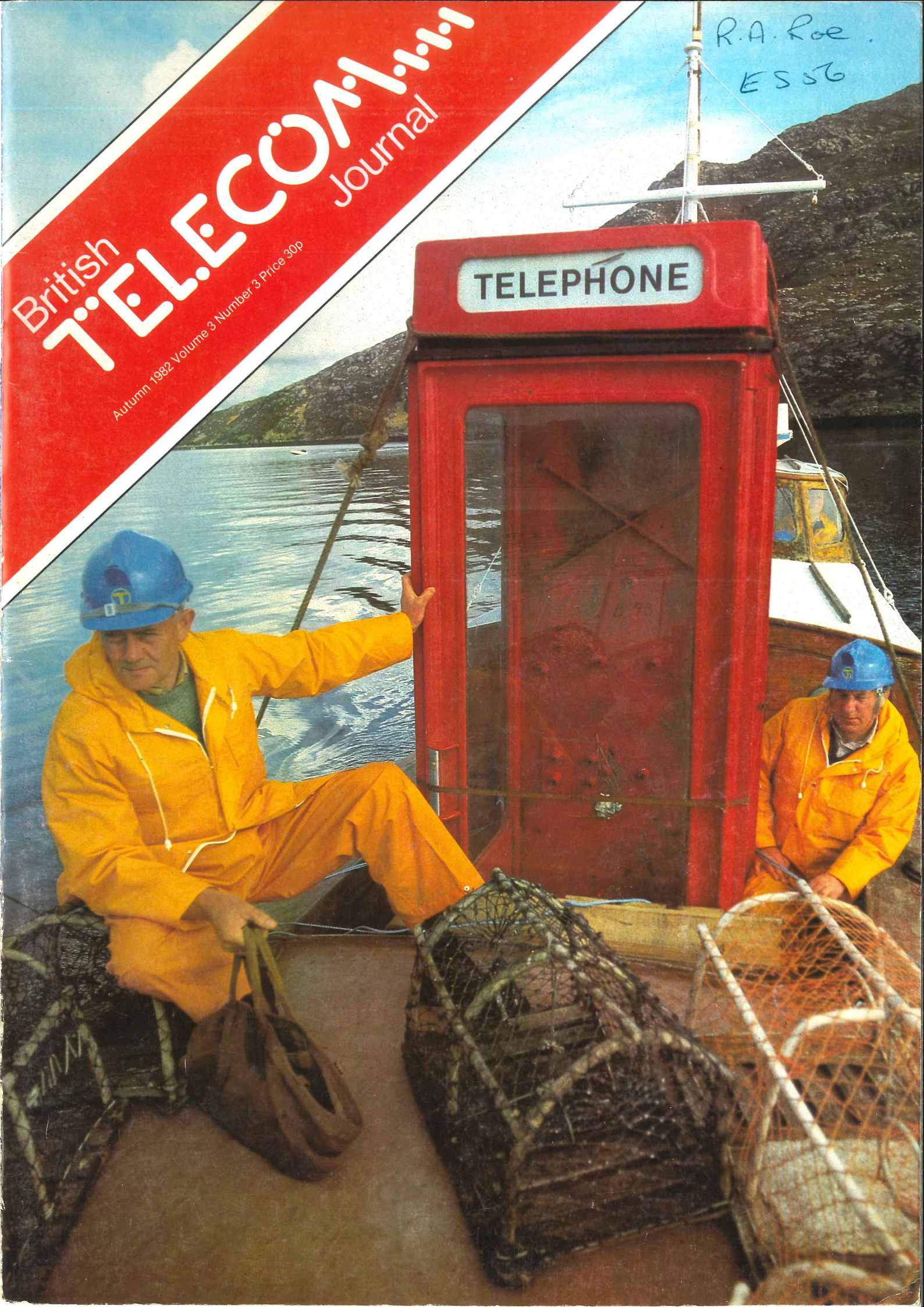
British TELECOM Journal
Autumn 1982 Volume 3 Number 3 Price 30p



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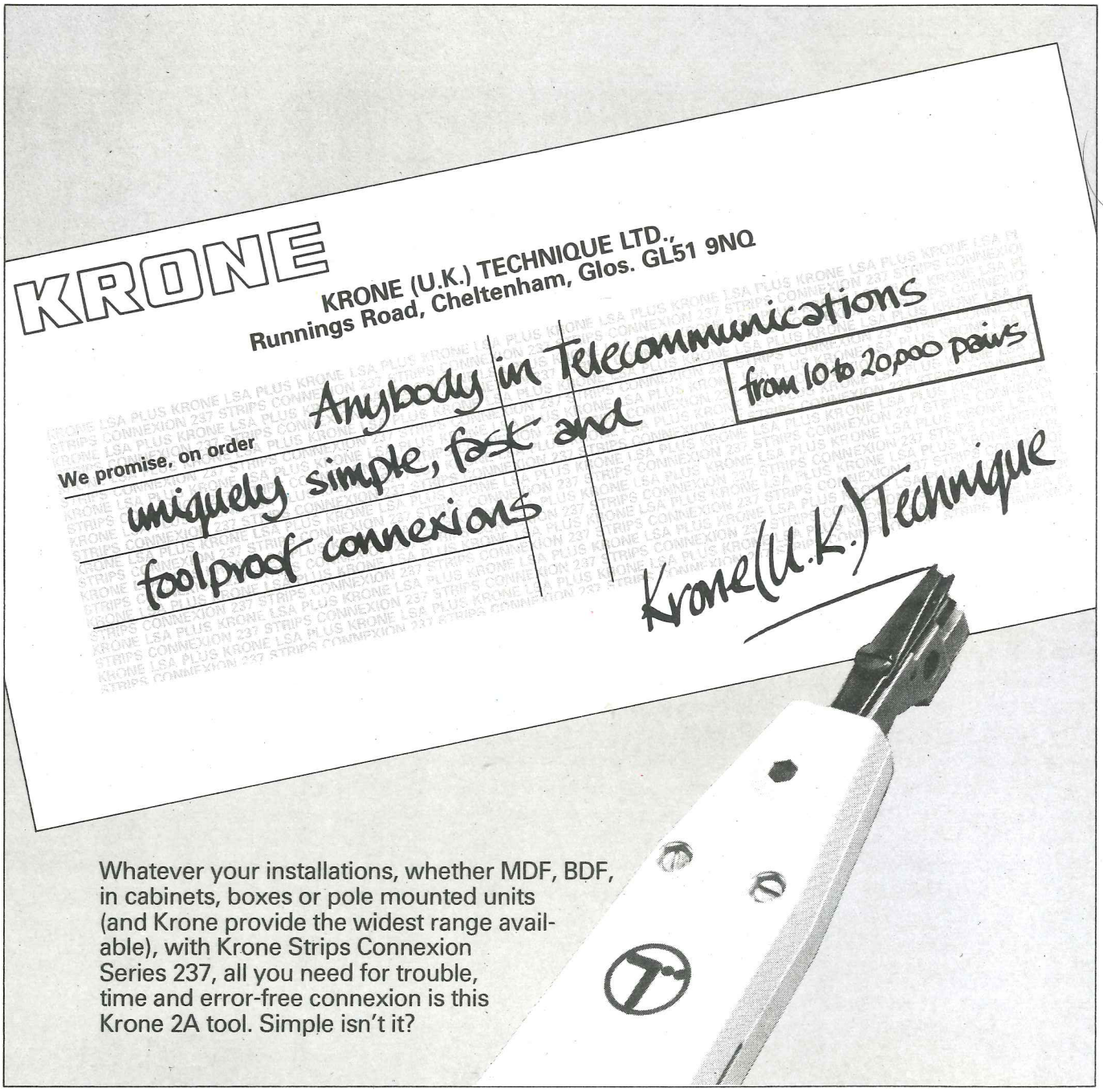

Whatever your installations, whether MDF, BDF, in cabinets, boxes or pole mounted units (and Krone provide the widest range available), with Krone Strips Connexion Series 237, all you need for trouble, time and error-free connexion is this Krone 2A tool. Simple isn't it?

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Well, how do you like it?

Good morning, Critchley.

Oh, good morning. I saw your advertisement for customized card frames in British Telecom Journal.

Oh yes. And how can I help?

Well, we could have – or should I say we've got – a housing problem with a new project.

Sounds just our cup of tea.

If you'll pardon me for saying so, you're not the first to say that.

Ah, you've obviously spoken to others?

Well, yes.

And?

Very nice. Pleasant. Even helpful. But somehow they er...

Don't tell me. They wanted to sell you their standard card frames. Right?

Exactly right.

Well, to be honest, I'd recommend a standard card frame – if it fitted the bill. After all, we make enough of them. But most of our business is customized frames – which could be just what you're after.

I see. Sounds like you've come across this sort of problem before?

You could say that. In fact it sounds very similar to the work we're doing for British Telecom.

Oh really. What's that?

Now let me see. We've made frames to fit Strowger racks. Frames for subscriber carrier systems. And frames to carry modems. We've developed free-standing cases for internal telephone systems, and supplied cabinets complete with frames and all the fittings. Not to mention many other customized frames for the telecom industry.

I'll send you some photographs if you're interested.

Now that could be useful. And could you send a rep?

A rep? Sounds as if you'll need an engineer.

An engineer? Sounds just our cup of tea. And by-the-way, mine's with!

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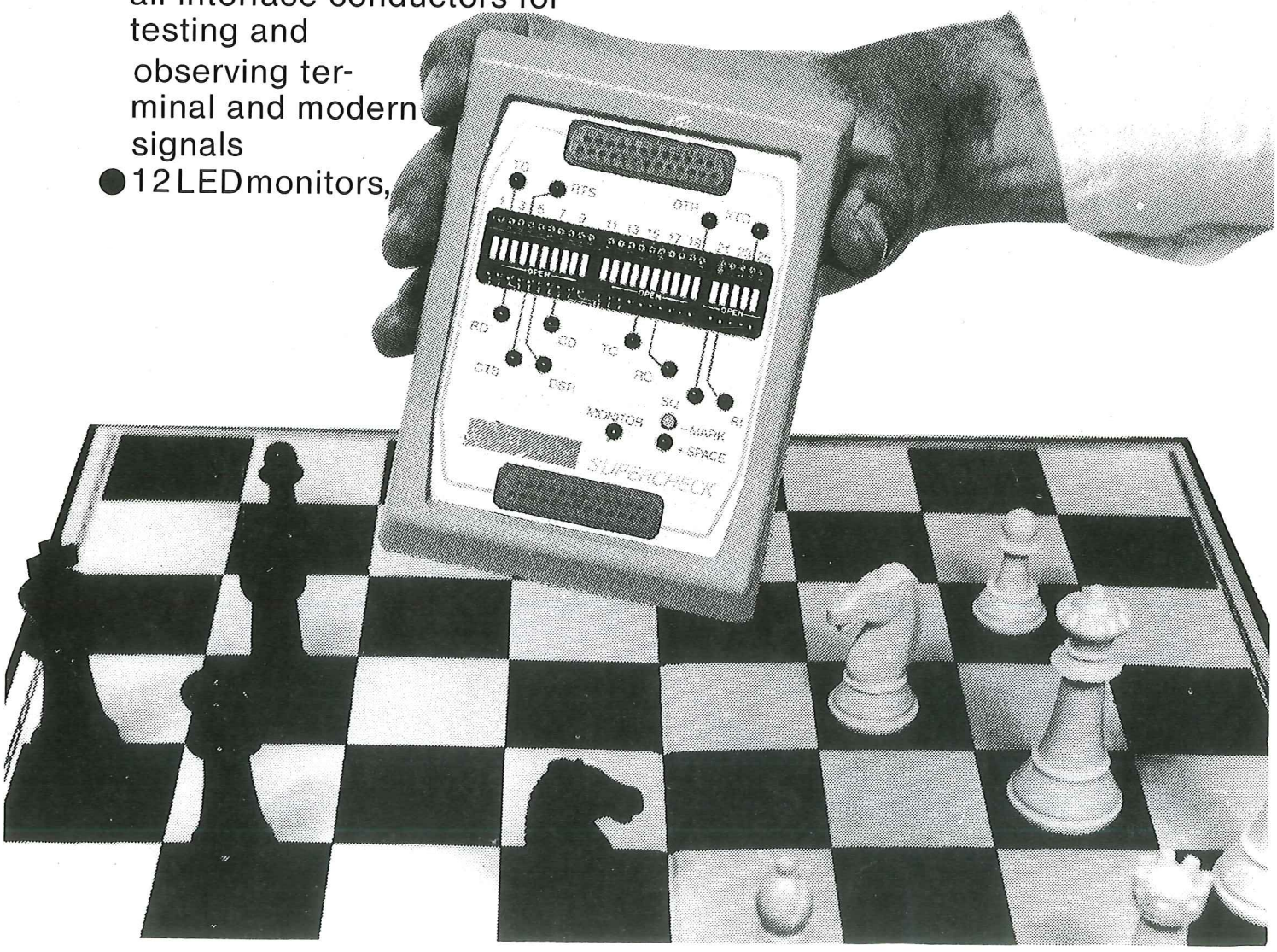

Plessey built the Payphone for rugged public service

The new Plessey Payphone is a line-powered, microprocessor-controlled system which provides an electronic coin validator, decadic or MF4 signalling, and a fully flexible software controlled call charge system.

There are two versions of the Payphone, and each of them satisfies the requirements of the major telephone authorities.

The Public Call Office version gives a high level of protection against vandalism and theft in unattended locations – and also against weather extremes.

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For further information, ask Plessey now.

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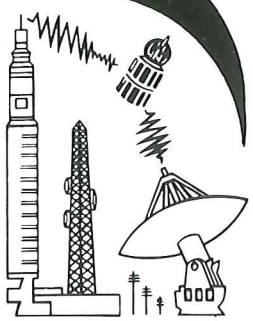

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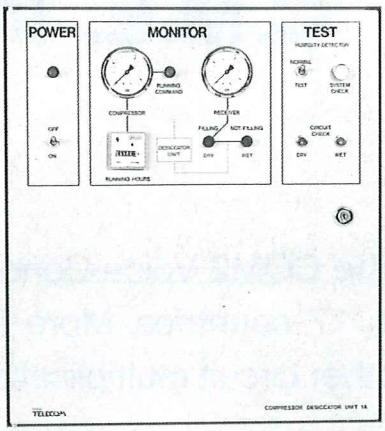


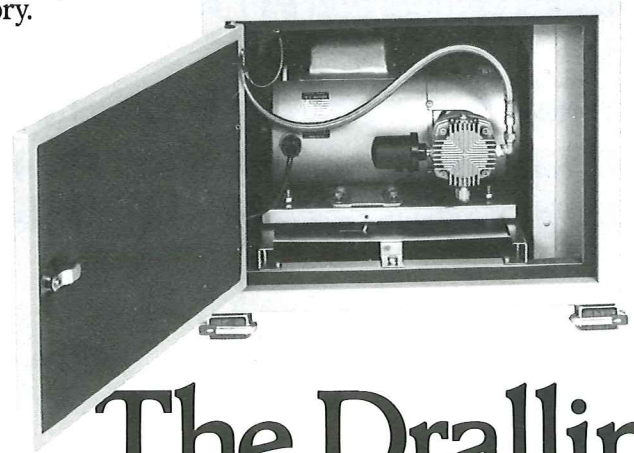
The latest in the 'Quiet Range' of gas pressurisation systems from Drallim Telecommunications, the Compressor Dessicator Type 1A, has been developed in co-operation with British Telecom. It is designed to provide a silent, compact and efficient operation.

Using the latest developments in technology, the design gives greater flexibility to suit customer requirements and allows easy access for servicing.

But that's only part of the story. As leaders in the field of pressurisation and monitoring, we ensure customer satisfaction by providing a complete service from consultancy, through design, manufacture and installation, to comprehensive after sales support.

For detailed information contact:-

Tim Knott
Marketing Manager



The Drallim compressor dessicator

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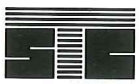
COM2 is meeting the needs of private leased line network users, carriers and PTT Administrations alike.

Whether your need is for just a handful of circuits, as few as five, or a large number–tens or hundreds– contact either of the addresses below for further details:



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Storage Technology Communications Corporation
Europe, Middle East & Africa–17 Old Court Place, Kensington, London W8 4PL, UK.
Telephone: 01-938 1991 Telex: 918076
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What will it cost to make your next computer a fail-safe one?

How about an extra 2% on the bill?

Recently we asked some computer users if they'd like a computer with resilience. The ability to bounce back quickly after going down. A bit like asking a Managing Director if he'd like a guaranteed profit!

Not surprisingly, they all answered "yes".

Then we asked if they'd be willing to pay a lot extra for it. A resounding "no", from all but a few special cases. Again, we didn't fall off our chairs in astonishment. In fact, we had confirmed our suspicions that people want their money's worth from the computer hardware they buy.

So we developed a new approach. One that lets you buy a transaction-processing computer from CTL with just the amount of resilience you need and can comfortably pay for.

We called it MOMENTUM.

With MOMENTUM you have several add-on options. The least expensive gives you instant recovery from a program failure, and full recovery from start-up after a power failure in a little more than a minute.

How much? Complete CTL systems start from about £50,000. MOMENTUM options start from around £1,000. When you need more performance and resilience, you just add more.

CTL computers offer a lot more besides.

Isn't it time we talked with **you?** We will, if you like. Just post the coupon.

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☐ Please contact me for an appointment.

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Telephone: (0442) 3272. Telex: 825052 BTJ 44

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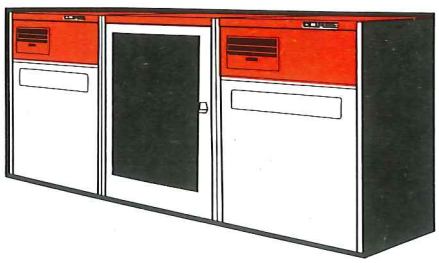

CTL Computer Technology Limited

an ITL Information Technology Company

The office of the future ends here.

The starting point for the office of the future is already sitting nicely on the desk.

It's the Plessey private business digital phone.

Using the compact Plessey digital exchange and its telephone wiring, Plessey is able to integrate workstations to make your word processing, desk top computing, mainframe computing, telex and viewdata more immediate and more accessible.

And give you a host of other electronic services – some still on the future microcircuits drawing board.

Plessey calls this integrated business information system Plessey IBIS. With a Dataplug you can even link non-Plessey equipment to it.

It's a system with all the benefits of Plessey modular technology – that makes business investment in new communications safer because it allows flexible expansion, and interfacing.

With Plessey IBIS, you can begin to build your future office with a single, stand-alone workstation, in the confidence that it's readily expandable in numbers and services to become a complete system.

With Plessey, it's all starting now, where it finishes. With the digital phone.

To find out more, contact John Reader, Plessey Communication Systems Limited, Beeston, Nottingham NG9 1LA.
Telephone: Nottingham (0602) 254822 Ext 3846.
Telex: 37201.
A Company within Plessey Telecommunications & Office Systems Limited, Edge Lane, Liverpool L7 9NW.

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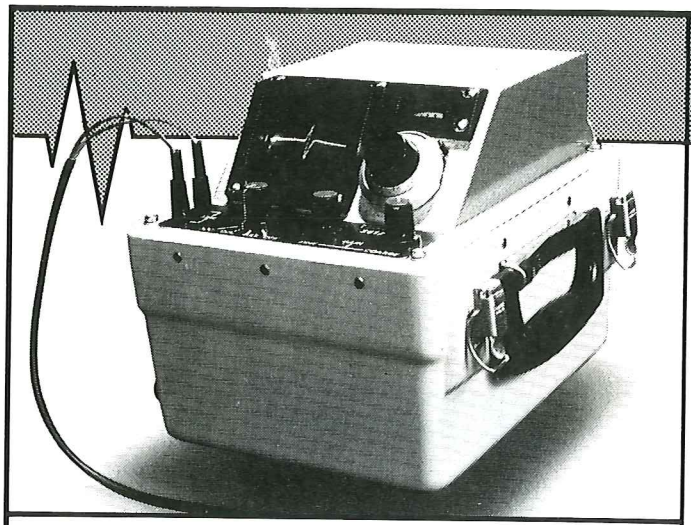
Ahead in business communications.



MINI-MOLE

FINDS LEAKS FASTER!

There's no hit or miss with this unique, robust and highly portable instrument. In seconds, it pinpoints faults with laboratory accuracy – but it is built as a rugged, simple, every day working tool for use in the field.

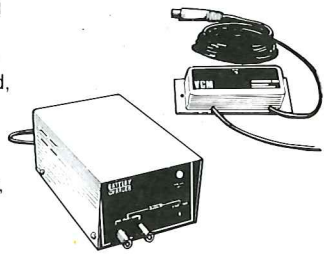
'MINI-MOLE' is British Telecom approved. It has immediate time and cost saving applications wherever underground or above ground networks are vital to communication. To P.T.T.'s it is an essential aid to constantly reliable operation.

Wherever there is a cable – there's a need for 'MINI-MOLE'. In factories, industrial and military installations, in ships, security systems, cable T.V. or any office where computers and electronic systems are essential to efficiency.

BRITISH TELECOM APPROVED

'MINI-MOLE' is battery operated and can be used anywhere – without mains supply. To ensure its constant readiness in the field, a mains battery charger and an in-vehicle charger module are available options.

'MINI-MOLE' finds faults quickly, accurately, simply and economically.



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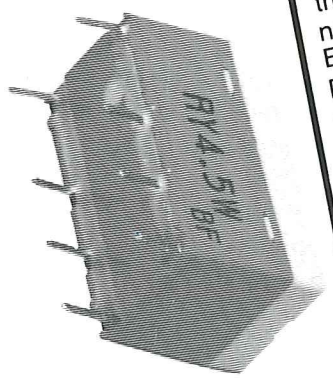
Ultra Sensitive Miniature Low Profile Relays



A new generation of ultra sensitive, miniature, low profile relays, the Takamisawa RY series, now available in the UK from ECC Electronics

Designed primarily to meet the stringent circuit requirements of the telecommunications industry, these relays are also particularly suitable for security and instrumentation applications where high quality and reliability are of paramount importance.

The outstanding feature of this new series of relays is their low power consumption compared with other, similar, styles of relays. Operating powers lie between 75 mW and 138mW (depending on coil voltage) at 20°C.

RY series relays have two changeover, bifurcated, contacts of 40/60 silver palladium as standard but versions with a 0.030mm layer of gold plating are available for extremely low level, or very infrequent, operating applications.

Standard contact ratings are: 1A at 24Vdc or 0.5A at 120Vac. Rated mechanical life is 20 million operations.

The Perfect Solution

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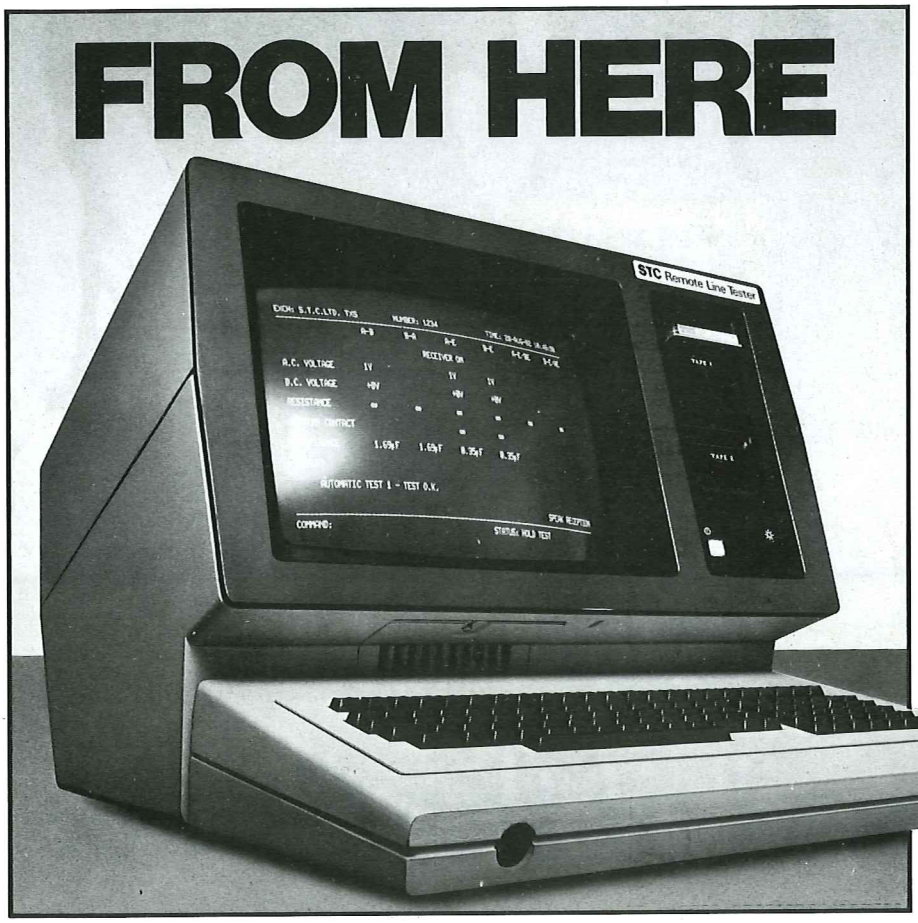
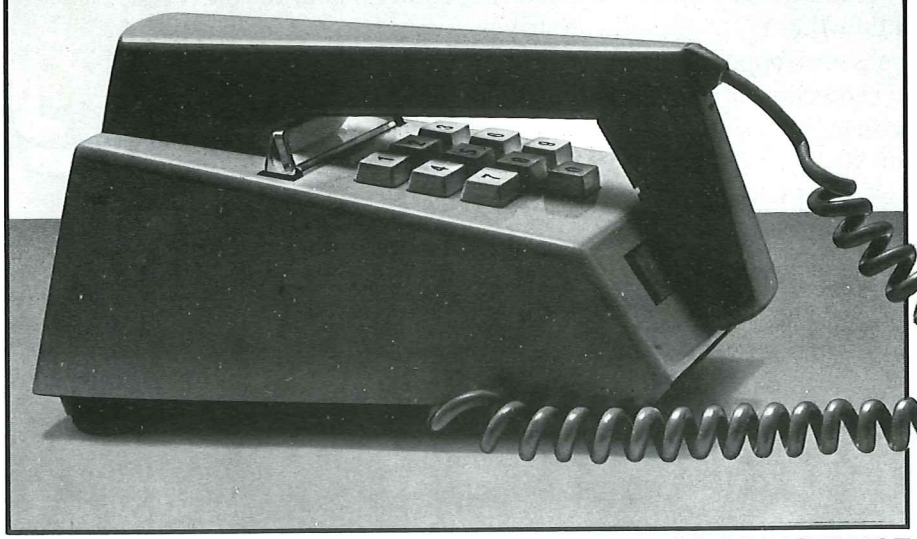


STC'S REMOTE LINE TESTER

TO ETERNITY



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The logical sequence of operations with STC's RLT means that little retraining of test operators is needed.

British Telecom set STC the problem of designing equipment which would improve the efficiency of STC's universally used machinery.

And the STC's Remote Line Tester was the answer.

If you would like to know more about the STC RLT, please ring us on 01-368 1234, or write to:
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Information Terminals Division,
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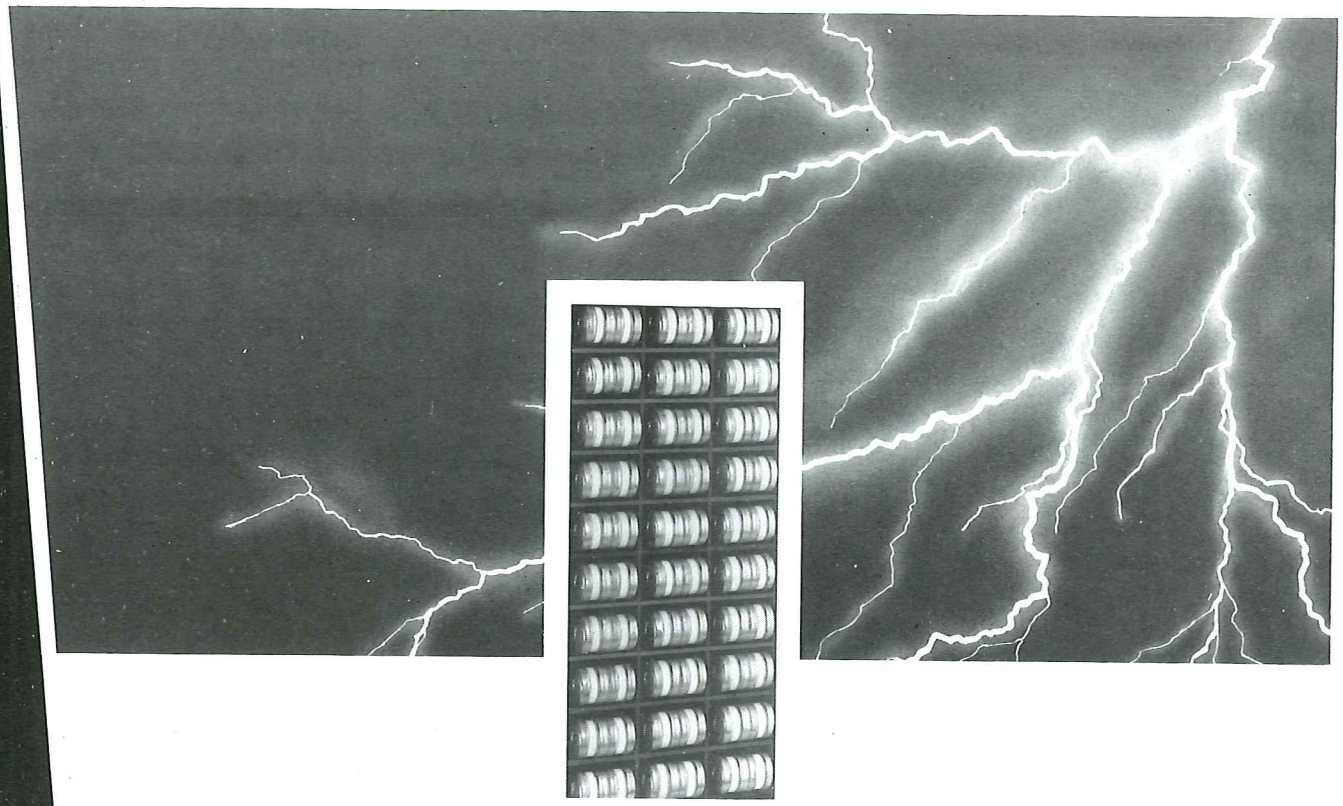
STC

INFORMATION TERMINALS DIVISION



Survival of the fitted.

This modern telephone equipment has protection "designed-in."

The reasons are well known to engineers – lightning strike or other electrical overloads can knock out whole telephone systems unless they are adequately protected.

Protected with M-OV surge arresters or gas-discharge tubes, if that's how you know them.

Electrical surges are stopped in their tracks by M-OV protection, at minimal cost, at great speed and *every* time.

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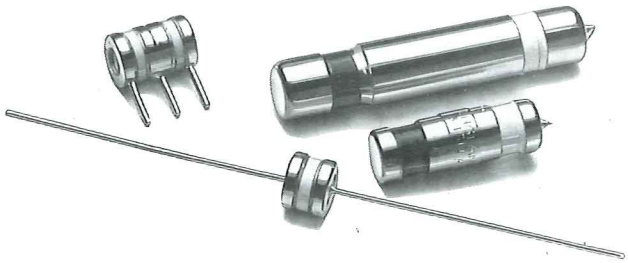
If your equipment needs protection, don't wait until you've got a strike on your hands. Get in touch with M-OV today.



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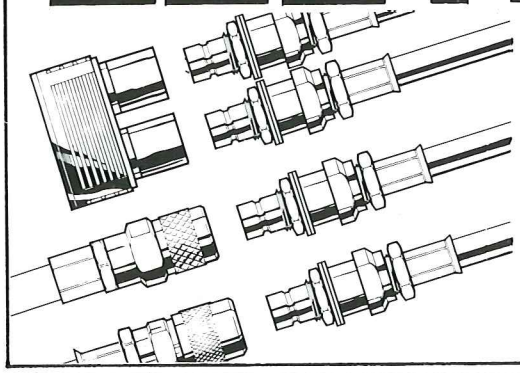

With confidence...

the telecommunications industry relies on LEETEC (formerly Lee Green Precision Industries Ltd.) for connectors produced to the exacting standards required on state of the art equipment practices.

...and rightly so

LEETEC now have qualification approval to BS 5750 Part II, including BT QM 1, as well as DEF STAN and BS 9000 approvals gained over the last 18 months.

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Here it is – the very first Department of Industry approved all-electronic telephone and answering machine combined! With push-button dialling...recording of callers' messages...remote playback (so you can call your machine from anywhere in the world and command it to play recorded messages to you)...self-diagnostic facility...and it counts and displays incoming calls.

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And in literally every aspect of it: for example from Strowger enlargements and the latest digital PABX systems to the most advanced microwave turnkey projects.

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We are a national UK distributor for Mitel and market Tellabs peripheral equipment in the UK, Eire and the Middle East.

We now manufacture our own range of call data loggers.

And as technology advances, we aim to keep one step ahead, offering the latest developments quickly, competitively and reliably.

After all, we are totally telecommunications.

Norton Telecommunications Limited
Norton House, Bilton Way, Luton, Bedfordshire LU1 1UU
Tel: Luton (0582) 416444 Telex: 826955

Other UK offices at Bristol, Hinckley and Stockport.
Associate companies in Eire and the Middle East.

Are spiralling Directory Enquiry costs your problem?

We at Hong Kong Telephone have increased the productivity of our Directory Enquiry staff by 70%. That means less people to recruit which adds up to much lower costs.

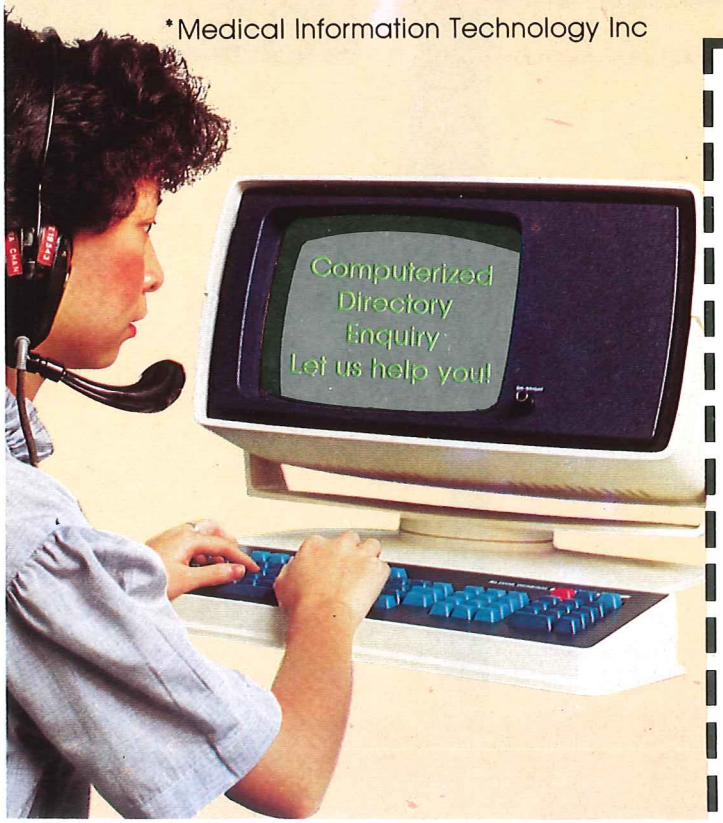
How? By giving each Directory Enquiry officer a visual display terminal linked to Data General mini-computers using software developed by Hong Kong Telephone and Meditech's* MIIS Operating System.

Software that has been running the Hong Kong Telephone Directory Enquiry Centre, without directories and without a hitch, for the last three years. And there are bonuses too. Optional subsystems incorporated into the software package offer instant directory update and automatic directory typesetting. Remote Enquiry features are also possible from Videotex type terminals. And as a totally dedicated modular system, it grows with you to meet your future needs.

We will be happy to discuss our well proven package with you and provide, as we did when the Indonesian Telecommunications Administration, PERUMTEL who bought it recently, full management consultancy and programming/operations training.

If you are looking at developing your own Directory Enquiry system, save yourself both the trouble and expense. Return the coupon below and get full details of the Hong Kong Telephone system. A system that handles over 160 000 Directory Enquiry calls a day, 16 000 in the busy hour, from only 156 operator positions. It's certainly worth looking into!

*Medical Information Technology Inc



HongKongTelephone
We help you keep in touch

To DP Manager
Hong Kong Telephone Company Limited
PO Box 479 GPO Hong Kong
Telex: 83338 TELCO HX

Please send me details of your Directory Enquiry software package

Name: _____

Position: _____

Company: _____

Address: _____

_____

Contact Telephone/Telex No: _____

_____

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British Telecom Journal
Autumn 1982 Volume 3 Number 3

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Published by British Telecom to promote and extend knowledge of the operation and management of telecommunications.

Cover: A journey by boat is the only way to get public call boxes out to some remote Scottish Isles. This kiosk – weighing more than threequarters of a ton – is leaving Loch Boisdale bound for Eriskay with two technicians from Benbecula.

Shares for all

The Government announcement that British Telecom is to become a public limited company with up to 51 per cent shares offered for sale in one or more batches after the next election, heralds the most far-reaching changes in the Corporation's history. The move would mean that British Telecom, while remaining a single entity with no hiving off of any constituent part, would no longer be subject to Treasury control and, for the first time, the British Telecom Board really would be free to exercise their responsibility for running the Business.

Other provisions are that the Government would hold 49 per cent of the shares and that there would be special opportunities for British Telecom employees to buy shares. The Government would relinquish control over the commercial decisions of the new company, which would look to its shareholders and the markets for its outside financing. Borrowing would no longer be subject to Exchequer control. Existing pension obligations would be safeguarded.

Responding to the announcement, the British Telecom Board welcomed the Secretary of State's commitment to full consultation but emphasised that it had not been consulted about the decision to turn British Telecom into a public company. It did, however, pledge that in working out details with the Government, every effort would be made to safeguard the interests of Telecom staff, create an environment offering a stable basis for the future and ensure that British Telecom served its customers well.

Industry Secretary, Patrick Jenkin, said the proposals were far reaching, would affect many people and followed naturally from the earlier liberalising measures. "It would make no sense to stop half-way", he said. "If those who work in telecommunications are to provide the range and quality of service which modern technology now permits and if they are to do so in competition with each other, it cannot be right that British Telecom should remain subject to the web of Government interference and controls which are the inevitable lot of an industry which enjoys the privilege of being financed from the Exchequer."

Meanwhile British Telecom Chairman Sir George Jefferson made it clear that the Government proposals in no way changed British Telecom's determination to improve its efficiency and services still further to meet the needs of the customer better than its competitors. "What we have to do now is make sure that the many important details still to be worked out add up to a good deal for British Telecom . . . our aim remains to provide service for all and to be better at it than anyone else."

Final instructions

L E Stent

A full set of current TIs takes up four of these cabinets. Barbara Buckingham, clerical assistant in Employee Relations Department, checks the index.

It is ten years since the introduction of Telecommunication Instructions (TIs) – regarded by many as the 'bible' of the Business. Now they are to be phased out by British Telecom in an attempt to give managers greater freedom. This article traces the development of a system which has now grown to 300,000,000 pages of information.

The TI system was set up in 1972 following the separation of the Post Office from the Civil Service. The main intention was to rationalise the numerous instructions, rule books, and manuals, and produce one cohesive instruction system which would better equip the then new Telecommunications Business to face the challenges of its changing environment.

In 1969, a study group produced a report making 45 recommendations considered necessary to create an efficient instruction system, and it is on this that the current system is based.

It centred around a network of British Telecom Headquarters (BTHQ) authors, TI advisers, print unit, local distribution centres and users. Distribution was computerised and recognised some 600 codes each related to a discrete area of work. By relying on internal printing and distribution, publication was geared to a target time of ten to 15 days thus improving radically on that achieved in earlier instruction systems.

The new TI system soon absorbed most of the various instructions which existed before 1969 including Engineering Instructions, Exchange Service Regulations, 'RG' Rule Books, Telephone Service Instructions, Telegraph Manual and Personnel Manual. The result was a highly efficient and sophisticated system which, in theory at least, presented the Business with an ideal management information system. It can be said that within the Post Office environment, the system served the telecommunications business well.

To policy-making departments at BTHQ, it produced a speedy and reliable means of distributing both 'mandatory' and 'non-mandatory' data to predetermined groups of staff with the added facility of readily being able to update or cancel the information. To users of the system it provided a central and authoritative reference point from which guidance and information on a wide range of topics could be obtained based on a comprehensive index system. In addition, each supervisor could organise a personal file of TIs which would contain all instructions relating to his or her work and would automatically attract other related instructions.

In practice, the system has grown into a massive industry in its own right. In 1981/82, some 26 million sheets of paper were issued and cost approximately £2 million to operate (disregarding author costs). In 1972/73, the TI system comprised 9,500 instructions. This figure has now grown to 12,500 and copies of these instructions are organised into over 130,000 TI files which collectively comprise 300,000,000 pages of information. Put into perspective, these statistics represent one TI file for every two members of staff or 1,200 pages of information for every individual employed by British Telecom.

The TI system, in fact, continues to flourish and until June this year, new or amended instructions were being issued at the rate of 30 a week and new files started at the rate of nearly 200 a week although this has been counterbalanced

Higher executive officer Vic Gardner has been responsible for producing and co-ordinating Telecommunications Instructions since their inception in 1972. Here he discusses future plans and policies with head of section Len Stent (seated).

to some extent by cancellations. The last financial year also saw the setting-up of nearly 50,000 files containing TIs on safety as part of British Telecom's efforts to conform to the Health and Safety at Work legislation.

Nor is the influence of TIs limited simply to British Telecom and the United Kingdom. More than 100 files are held (and paid for) by overseas groups such as the Departments of Telecommunications in Brunei and Jordan and, interestingly, the Department of Public Utilities in Papua New Guinea.

Although these figures on their own might be regarded as startling they are only symptoms of the problems affecting the instruction system. The major cause for concern is the restrictive effect that the system has on the activities of the Business and its managers. Almost every subject or activity in which the Business has an interest is covered in expansive detail in one or more TIs. In short, the system is smothering the Business with information that is either unnecessary or given in too much detail to too many people. Typical examples are TIs which cover the ordering of pens and how to avoid them leaking in the pocket (12,000 copies); how to use a pair of binoculars (3,000 copies); description of padlocks (10,000 copies); cleaning of paint brushes (1,600 copies); and details of hand protectors (15,000 copies). And many other examples exist.

The imperfections that existed or have developed in the TI system have been recognised for many years. For example, in 1977, the Carter Committee recommended that instruction systems should be reviewed so that they became a general guide to correct practice but did not act to limit new ideas and would leave freedom for locally-negotiated change. The comments made then are even more relevant in today's competitive environment. Efforts made in recent years to control the system more rigidly, by involving regions in the procedures and restricting continued growth in the system have met with what can only be described as limited success.

BTHQ authors continue to issue instructions on subjects that they consider regions and areas should implement and on the distribution patterns the author determines. Regions and areas, in the main, passively accept these judgements even though the facility exists for a Director to challenge the need for any TI to be applied in his region.

The overall result has been to inhibit devolution, stifle the initiatives of local managers, protect the manager who is against change, smother the Business with information that is often unnecessary or too detailed and perpetuate bureaucratic procedures in offices up and down the country.

The Business has now moved away from traditional departmental organisation and is developing as a number of largely independent operating divisions. With the growing emphasis on devolution, profit centres and local accountability, the continuation of an all embracing instruction system controlled rigidly from the centre and accepted passively in the field is not realistic nor suited to the organisation.

British Telecom unions are being consulted about the run down of the TI system, expected to take about two years to complete. For the rest of this year, printing restrictions have been introduced to limit the issue of new and amended TIs and no new TIs will be issued from the end of this year. TIs still in existence at that time may remain in force until the end of 1984 when the complete TI system will eventually be phased out.

Meanwhile each operating division will develop its own pattern of instruction, guidance and other informative material designed to meet the particular needs of its functions, work and organisation. But although central instructions will continue to be issued for items on which consistency throughout the Business is essential, it is not intended that TIs will continue simply under another name. The TI computer distribution system has been in use for ten years and now has a limited operating life. New systems will therefore be able to develop distribution patterns to be determined by HQ units, regions and areas based on their own priorities and considerations. In addition, strict budgetary constraints are likely to be introduced to restrict unnecessarily wide distribution.

The cultural changes implicit in the decision to abandon TIs will be dramatic and are designed to show staff at all levels of the determination to rid the Business of its present bureaucratic processes. It is intended to encourage initiative and allow businesses to be run locally in the light of conditions existing at the time.

Success will only be achieved, however, if the designers of the new systems and future authors and users grasp the basic concept that new and varied management styles are essential if each of the businesses is to prosper in the new commercial environment.

Mr L. E. Stent is a head of section in Employee Relations Department and is responsible for senior salary structure, job evaluation and TI co-ordination.

British Telecom Journal, Autumn 1982

Wired into the future

J R Fox

One of the Milton Keynes families taking part in the Fibrevision trial settle down for an evening's viewing.

Fibrevision, Britain's first telecommunications cable network using hair-thin glass fibres to carry television, radio and other services into the homes of 18 families, is now operating on a two-year trial basis at Milton Keynes in Buckinghamshire.

The idea to mount a cable television trial using optical fibre transmission based on pulse frequency modulation (PFM) was conceived about three years ago by British Telecom as an initial step to providing wideband services in the local network.

The trial employs a new type of star network and, rather than use the conventional tree-type distribution, is equipped with a microprocessor-controlled wideband switch to route the required programme through to customers. The system was developed at the British Telecom Research Laboratories, Martlesham and installed with the help of Transmission Department and British Telecom Eastern. The optical links were designed by Standard Telecommunication Laboratories Limited (STL), Harlow and manufactured by ITT at Leeds.

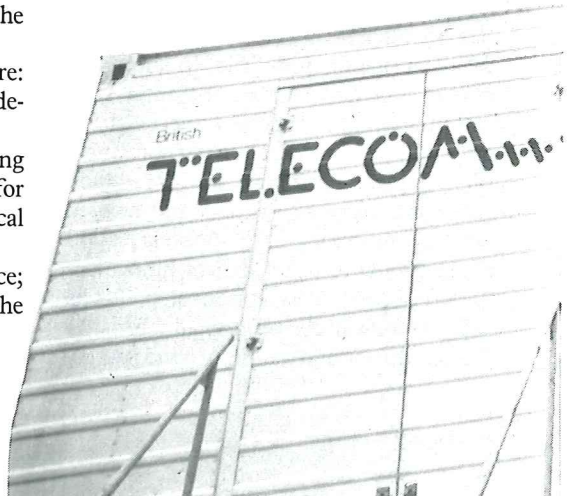
The obvious service on which to base the network was cable television, with its existing requirement for wideband transmission and future potential for enhancement. A technical assessment was made at BTRL by implementing a skeleton system using optical fibre cable pulled into a duct route on the site. Prototype optical modules from STL and all other elements of the system were tried before implementing the equipment for the public trial at Milton Keynes.

The aims of the Milton Keynes trial are:

* To show and stimulate interest in wideband services to the customer;
* To assess the performance of existing optical communication technology for this application and to identify critical problem areas;
* To gain technical and field experience;
* To assess customer reaction to the system.

Each of the 18 families in the trial can choose from six television channels, FM radio and pay-TV programmes already operating locally. Through the network they can also use Prestel to gain access to 200,000 pages of information and transactions for display on an ordinary television receiver.

With the PFM transmission scheme, the services are sent as pulses of light at a rate of 25 million a second, along the wideband 'Fibrevision' cables. Pulses are finally converted by electronic equipment in the customer's home into signals received by the television or radio set.



All available television programmes are received on aerials at the existing cable television 'head-on', from where British Telecom provides conventional coaxial cable television service to the whole of Milton Keynes. The programmes are down-converted to baseband and separated into individual channels. A channel is also formed consisting of the FM radio programmes and each channel is fed to its own transmitter unit with a first stage of pulse frequency modulation followed by the optical drive.

A fully-equipped ten-fibre cable carries the channels – one per fibre – from the head-end to the flexibility point. This link of over three kilometres contains low-loss fibre in four lengths of cable fusion-jointed along the route.

The hub of the system is the flexibility point where all available programme material is routed out on individual links to customers. A full-scale system would have a number of these distribution points, situated close to the customer and each serving probably a few hundred homes. A given primary link feed need not be dedicated to one flexibility point, but could distribute material to more distant ones provided quality can be maintained. For convenience at Milton Keynes the single distribution point is a small brick building – destined to be the local cricket club's scorebox. Here the incoming fibre terminates on an optical receiver which converts to a PFM electrical signal, ready to input to the wideband switch.

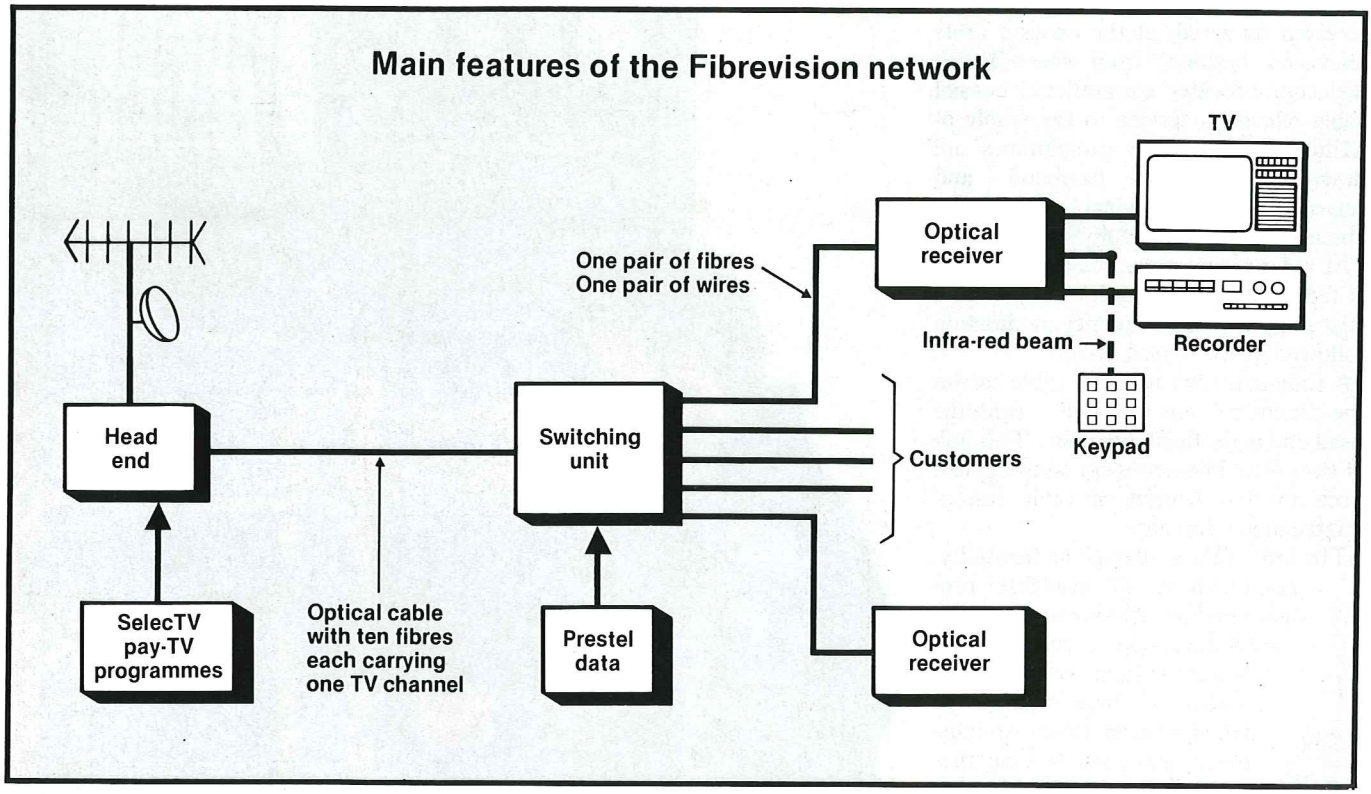
Dr J R Fox, author of this article, installs an optical receiver unit into the equipment rack inside the flexibility point of the Fibrevision system.

The Intel 8085 microprocessor at the flexibility point scans customer signalling input cards which receive any requests for programme changes. It then operates the switch accordingly. In addition it receives monitoring information about transmission on both primary and secondary links. Microprocessor operation is checked by a watchdog timer which has to be retriggered at regular intervals by outputs from the control. Printouts on link failures and alarms are provided over a wire link to the head-end, where input facilities are also available to send both administrative and maintenance information back to the control.

From the distribution point, a secondary link of between 50 and 200 metres goes to each customer. This uses cable containing two fibres plus two copper-coated strength members. Again a single channel is carried by each fibre. The two strength members are used to carry signalling information back from the customer's end to the microprocessor control.

Signals on the two incoming fibre links to

Television, pay TV and radio programmes are fed into the Fibrevision network at the head end at Linford, Milton Keynes.



each home feed into an optical receiver and are then demodulated to baseband. A television channel is up-converted to the ultra high frequency (UHF) band to feed a normal aerial socket on a television set.

Where a receiver has a video - baseband -input however, an option is to provide this directly. The radio multiplex is confined to coming in on one link so that only one up-converter is needed to return it to its normal very high frequency (VHF) band.

Reception and conversion equipment, with an associated power supply, is mounted locally in an external meter cupboard or on the garage wall at the customer's home.

Monitoring for transmission failure over the links is also carried out at this point and the result combined with signalling information before being transmitted back to the flexibility point.

A final coaxial cable feed is taken to the customer's television and radio receivers inside the home, while a wire pair carries the customer's signals from an infra-red receiver mounted on the living room wall. This is activated from a hand-held push-button channel selector used to indicate the required programmes to be switched onto the two incoming links.

The advantages of the type of network used in the trial and the good quality achieved with the chosen transmission method have already been proved. Still being evaluated is the practicality of the techniques used and it is these that will be used as a stepping stone to future developments.

An engineer uses a fusion jointing machine to link lengths of fibre cable.

Dr J. R. Fox is a head of group in Research Department's Digital Transmission and Local Distribution Division. He was responsible for wideband local networks and played a key role in the Milton Keynes trial.

British Telecom Journal, Autumn 1982

It started with a BANG....

An accident in the laboratories of Imperial Chemical Industries (ICI) nearly 50 years ago led to the discovery of polyethylene – a material used throughout British Telecom as cable insulation. Here **Mr J C Duncan,** an assistant executive engineer in Reading Area, traces the development of polyethylene from its explosive beginnings to the present day.

Polyethylene has been extensively used to insulate telephone cables throughout the British Telecom network for many years.

According to the historian Antonio de Herrera, Christopher Colombus, on his second voyage of discovery (1493–96), saw the inhabitants of Haiti playing with bouncing balls made from the gum of a tree. Before long, rubber attracted the attention of American and European scientists and industrial entrepreneurs, resulting in the new industries of showerproof garments and elastic fabrics.

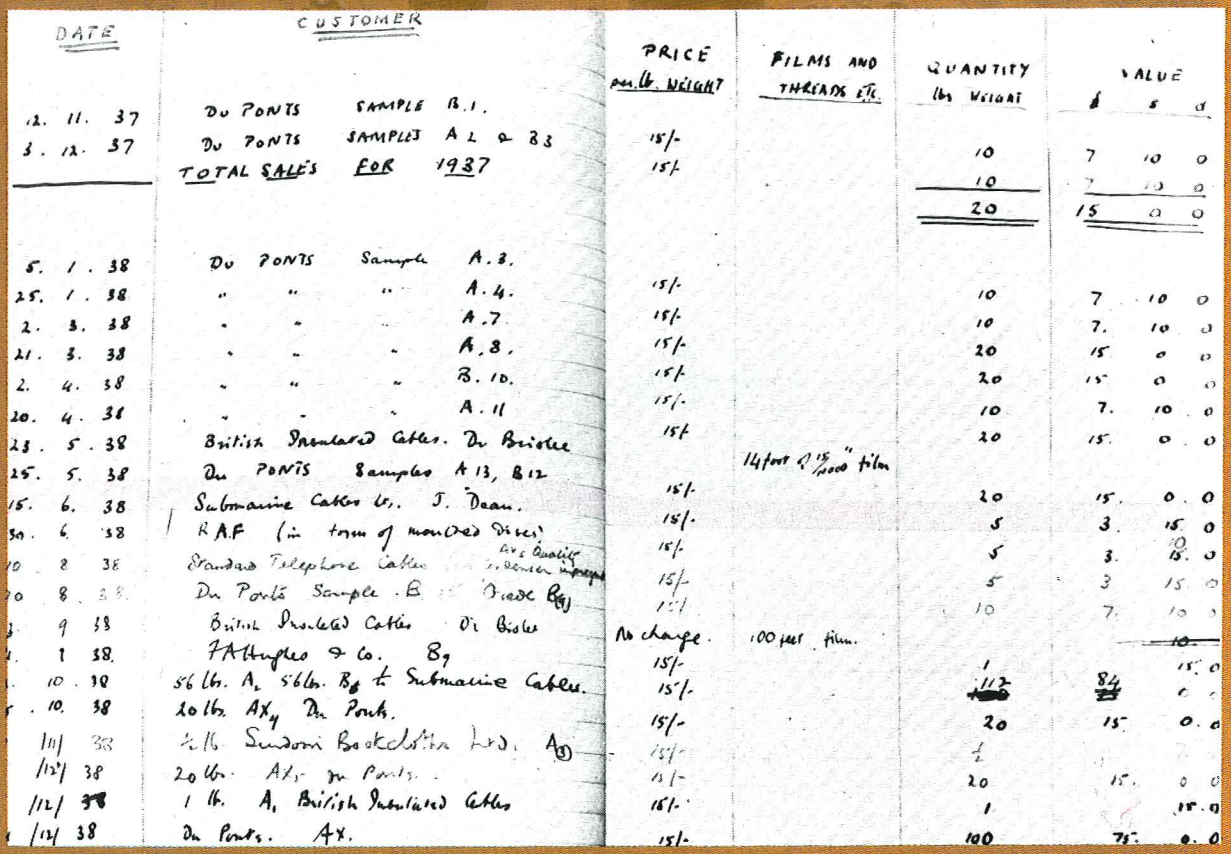
The discovery of vulcanisation by Charles Goodyear in 1839 – a process where rubber is mixed with sulphur to produce a compound with high electrical and chemical resistance – was a scientific breakthrough for wire insulation. But as a cable sheathing material it had a serious weakness – it could not resist moisture for long.

Soon, a new resin was to attract the attention of electrical engineers – a gum extracted from the leaves and bark of a tree belonging to the 'sapindaceae' family found in Malaysia and the South Sea Islands. John Tradescant, a traveller and collector of curiosities, was the first to bring samples of the gum to Europe.

Michael Faraday, a member of the Royal Society, evaluated specimens of the gum in 1843. He found that the substance, called 'Percha' by the natives, meaning 'gum tree', had unique properties. Although closely allied in chemical structure to natural rubber, its physical texture resembled that of leather. If heated to 100 degrees centigrade, it could easily be moulded to a variety of shapes, and remain in the precise form when cold. Not only did it have excellent dielectric qualities, but it was resistant to many chemicals.

Faraday suggested that gutta percha would make a good insulant for underground and submarine cables. Current methods of cable manufacture and choice of materials were extremely unsatisfactory, and a water-resistant material offering high insulation was urgently needed. At Folkestone, a two-mile trial length of wire, coated with gutta percha, was laid in the Channel. One end was terminated aboard the *Princess Clementine*, moored at the quay, with the other end connected to the railway telegraph line. Messages were transmitted to London from the ship via the cable, a distance of 85 miles.

Although gutta percha gave reasonable insulation for both underground and submarine cables, the problem of providing external protection remained. This was overcome by wrapping helical layers of zinc-coated iron wires along the length of the cable. Despite occasional ruptures caused by sharp pieces of zinc metal piercing the gutta percha, the cables gave about ten years service. And, in the case of submarine cables, the gutta percha had to be protected by a special tape from a little creature called the terado worm.



DATE	CUSTOMER	PRICE per lb. WEIGHT	FILMS AND THREADS ETC.	QUANTITY lbs WEIGHT	VALUE £	s	d
12. 11. 37	Du PONTS SAMPLE B.1.						
3. 12. 37	Du PONTS SAMPLES A 2 & B 3	15/-		10	7	10	0
	TOTAL SALES FOR 1937	15/-		10	7	10	0
				20	15	0	0
5. 1. 38	Du PONTS Sample A.3.						
25. 1. 38	" " " A.4.	15/-		10	7	10	0
2. 3. 38	" " " A.7.	15/-		10	7.	10	0
21. 3. 38	" " " A.8.	15/-		20	15	0	0
2. 4. 38	" " " B.10.	15/-		20	15	0	0
20. 4. 38	" " " A.11	15/-		10	7.	10	0
23. 5. 38	British Insulated Cables. Dr Bristee	15/-		20	15.	0	0
25. 5. 38	Du PONTS Samples A 13, B 12		14 foot of 15/1000" film				
15. 6. 38	Submarine Cables Ltd. J. Dean.	15/-		20	15.	0	0
30. 6. 38	R.A.F (in form of mounted discs)	15/-		5	3.	15	0
10. 8. 38	Standard Telephone Cables [illegible] Ax's Quality [illegible]	15/-		5	3.	10 15	0
10. 8. 38	Du Ponts Sample B [illegible] Grade B(4)	15/-		5	3	15	0
3. 9. 38	British Insulated Cables Dr Bristee	15/-		10	7.	10	0
1. 9. 38	F A Hughes & Co. B9	No charge.	100 feet film.			~~10~~	
10. 10. 38	56 lbs. A2 56 lbs. B6 to Submarine Cables.	15/-		1		15	0
10. 10. 38	20 lbs. AX4 Du Ponts.	15/-		112	84	0	0
/11/ 38	½ lb. Sundorn Bookcloths Ltd. A(3)	15/-		20	15	0	0
/12/ 38	20 lbs. AX5 Du Ponts.	15/-		½			
/12/ 38	1 lb. A1 British Insulated Cables	15/-		20	15.	0	0
/12/ 38	Du Ponts. AX.	15/-		1		15	0
		15/-		100	75.	0	0

This ICI ledger for June 1938 shows the first order for 5lbs of the new polyethylene.

But it was not until the 1880s – a time of rapid progress in telecommunications – that a new cable, giving improved transmission with economical savings, became popular. Dry core, as it became known, was a result of continuous research, and was a lead-covered cable with paper-insulated copper conductors and cotton threads. Although this resulted in much better electrical insulation properties than gutta percha, it had a major weakness. When the lead sheath was ruptured the paper quickly absorbed moisture and resulted in low insulation.

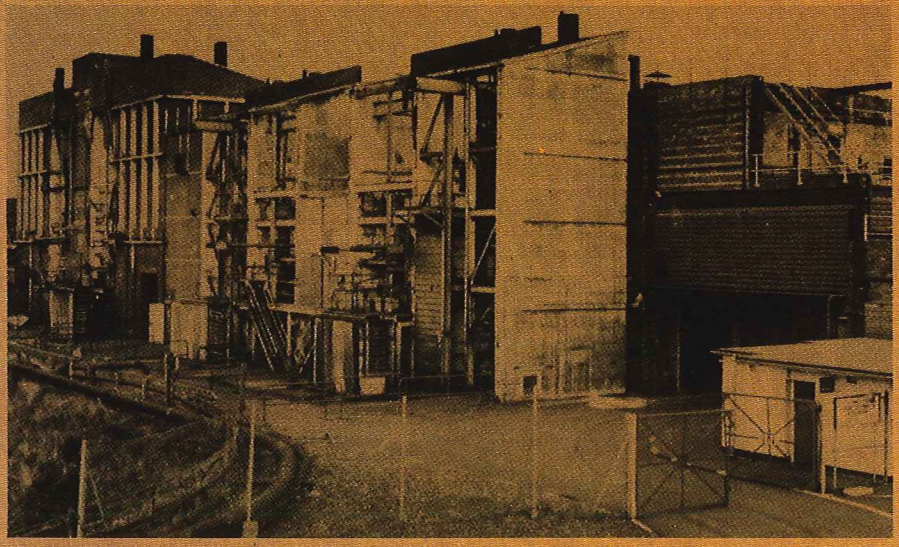
When Captain Scott and his companions made their brilliant dash for the South Pole in 1910, they took with them a pair of field telephones, a gift from the National Telephone Company, and reels of 1mm diameter wire. To keep weight to a minimum, the wire was uninsulated, and when used was laid directly onto the uncontaminated snow and ice – proving that pure water is a bad conductor of electricity.

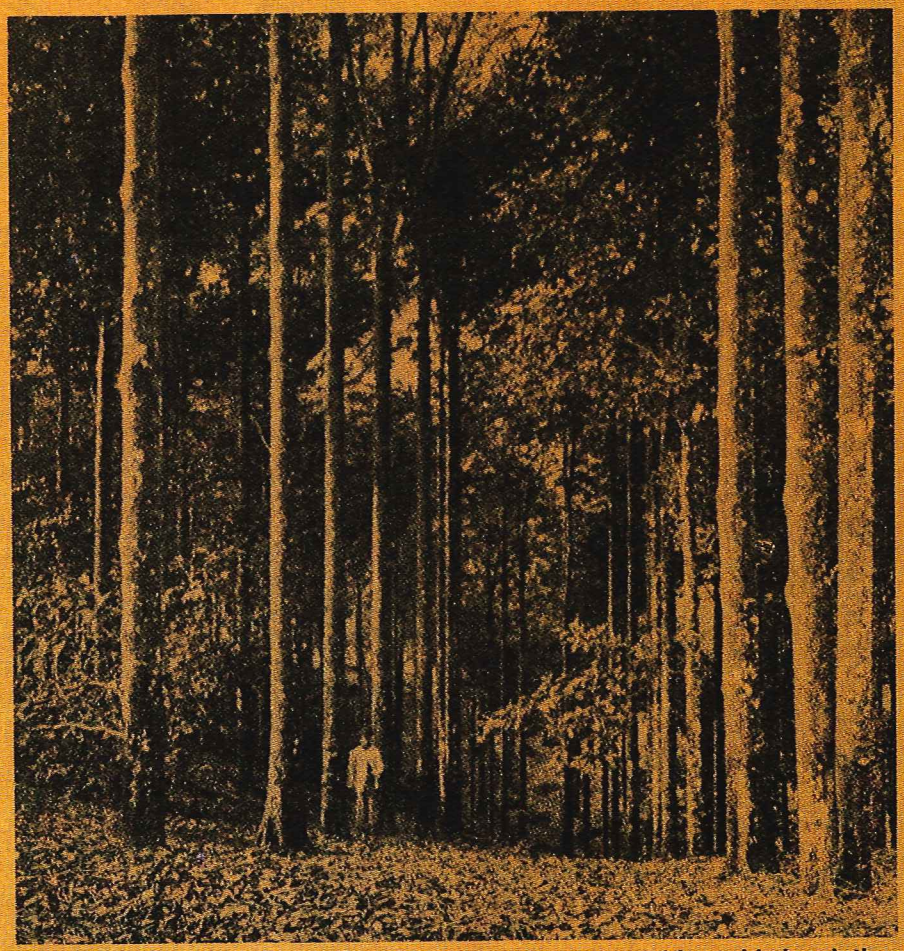
After 1920, increasing submarine cable provision called for more gutta percha output – a demand that was becoming increasingly difficult to satisfy. Each nautical mile of cable needed 150 kilogrammes of the material. To add to the difficulties, the price was now spiralling upwards and very few trees were left. Profiteers found that the quickest method of collecting the leaves and tapping the bark, was to cut the tree down.

During the 1930s, however, it was discovered that the dielectric qualities of gutta percha could be improved by blending the purified product with petroleum jelly, de-proteinised rubber or other hydrocarbon substances. This lowered the permittivity, allowing increased transmission frequencies, and thereby increasing the capacity of the cable. But without repeater equipment to amplify the diminishing signal strength, the maximum transmission distance was severely limited.

The wireless was fast developing and

A picture taken in September 1939 of the ICI plant in Cheshire at the time when the polyethylene used in the experimental Isle of Wight submarine cable was produced.





A gutta percha plantation in Java. Gutta percha was used for cable insulation by the Post Office before the discovery of polyethylene.

posed a serious threat to underground and submarine telephony, especially long-distance communications. Clearly a new insulating material was needed if cable performance was to keep abreast of the most up-to-date innovations in telecommunications. Fortunately, at about this time, research work entirely unconnected with telecommunications was taking place at the Imperial Chemical Industries (ICI) laboratories in Winnington, Cheshire.

A research team had been experimenting with high-pressure chemical reactions involving organic substances inert at normal temperatures and pressure. The series of experiments began with the invention of a compressor by a Dutch scientist – Dr A Michels – working at the University of Leyden. His machine could operate at temperatures of 200 degrees centigrade and at pressures 3,000 times the earth's atmosphere. ICI had obtained a machine in 1931, and were systematically working through a prepared list of chemicals subjecting them to enormous pressures and observing their reactions.

One gas that attracted the attention of the ICI team was ethylene, a natural gas found in oil fields and coal gas. In March 1933, the researchers put some ethylene with a little benzaldehyde to act as a catalyst in the reaction chamber of the compressor and raised the air pressure to 2,000 atmospheres at a temperature of 170 degrees centigrade. To allow time for any reaction to take place it was decided to leave the reactor under pressure throughout the weekend.

When they returned on the following Monday, the researchers found that a sealing gland had blown and the pressure had escaped. Although the benzaldehyde had not entered into any chemical combination with the ethylene, it had mixed with the temperature controlling oil which had been circulating around the chamber jacket. But when the machine was stripped down it was found that a wax deposit, similar in texture to paraffin wax, was precipitated on the reactor walls. A new substance – polyethylene – had been discovered . . .

Because of its superior dielectric qualities and chemical resistance combined with flexibility, lightness and inexpensive production costs, polythene – a shortened name for polyethylene – was the obvious successor to gutta percha. Between 1938 and 1939, the first polyethylene-insulated coaxial submarine cable was made adapting an extrusion machine used for gutta percha. A mile of experimental cable was subsequently laid for the Post Office, between the Isle of Wight and the mainland.

When war was declared in 1939, production of polyethylene, then running at about 100 tonnes a year was diverted to the war effort for the manufacture of coaxial cables. As the war progressed and the tide turned to Britain and her allies, polymer production gained impetus and more than 1,000 miles of polyethylene cable were manufactured and distributed to depots throughout southern England in readiness for the forthcoming invasion of Europe.

After the war, restrictions of polyethylene raw materials were relaxed and again cables could be produced for the consumer market. In mid-1945, the Post Office, in its first post-war offshore cabling project, became directly involved in providing circuits between London and Hamburg. Cable ships *Ariel* and *Bullhead* laid 197 miles of polyethylene-insulated cable across the North Sea, between Lowestoft and Borkum, a small island off the German coast. There now seemed no reason not to extend the use of polyethylene for external sheathing on underground cables.

With the cost of lead steadily rising, and the cost of polyethylene decreasing, the economics of an all-plastic cable were becoming increasingly attractive. A non-corrodable material was needed for an all-out replacement of the existing lead cable distribution network. By 1950, the Post Office had inaugurated systematic field trials of an all-plastic, small diameter cable.

And now polyethylene is celebrating its 50th anniversary as the leading modern telecommunications polymer. Historically its predecessor – gutta percha – reigned for more than half a century as the main insulation for telecommunication cables. Today its commercial viability is almost extinct but in one case it is still ahead of man-made polymers – as a sheathing material for golf balls.

Today's developments in telecommunication systems using previously unheard of frequencies and laser applications may well, within the next decade, preclude the need for further developments in insulation. But a polymer of some fundamentally new material may be required – one that can stand the test of time but one far superior to that of polyethylene. Perhaps it will take another accident . . .

Selling – the key to success

Peter Chamberlain.

Even before the second world war, the General Post Office (GPO) employed 'salesmen'. Called 'contract officers', they were part of the clerical and executive hierarchy, and their job was to further the aims of the telephone side of the Business. They were engaged on a salary plus commission basis – 2/6 (12½p) for an exchange line and sixpence (2½p) for an extension to encourage both business and residential use of the facilities which were available at the time.

Earlier this year, British Telecom appointed a top commercial sales executive to spearhead its revitalised sales force. Here, **Peter Chamberlain,** director of sales for business products and systems, outlines the story so far and spells out his plans for the future.

After the war, the GPO reappraised its method of conducting business and as part of this, a separately graded structure, the 'Sales Division', was created in 1948. Part of this new organisation was the establishment of a specific selling grade – the sales representative. It was his job to seek new business, advise customers on the best means of meeting their needs and forecast the future levels of provision of line plant to customers' premises.

Sales representatives were based in telephone areas and soon became knowledgable about their 'patch'. They became familiar figures in the same territory for many years, had their homes in that area and became well known members of the community.

For both contract officers and sales representatives, a great deal of time was spent on the residential market, encouraging greater use of the telephone and overcoming shared service objections. It was this work that resulted in the phrase 'much walking in all weathers', commonly used in the recruitment advertising of the day.

The GPO monopoly meant that on the whole, the sales force was not in a position to stimulate demand and as a result became service-orientated and demand-responsive. Under the old monopoly conditions, the Post Office decided which equipment could be connected to and used on the public switched telephone network. This led to many criticisms including those of little or no choice of products, overlong provision timescales and complacency. In the end, all of these led to requests for Government action to curtail the Post Office's powers and to open up the market for telecommunications equipment to a much wider field of potential suppliers. Efforts of lobbyists and pressure groups culminated in the British Telecommunications Act 1981.

This new Act has given the private sector freedom to use British Telecom's inland network so it can compete in the supply of the ever-growing range of services and apparatus. But at the same time, British Telecom was undergoing a

Marketing account executive Charlie Curley from London's Centre Area prepares to call on a major advertising agency in the West End.

critical self-analysis and had recognised the twin needs of greater accountability and better mobility of the sales force.

To meet the demands of modernising British Telecom management, staffing, and finance as well as the impending challenge of competition, large-scale reorganisation was needed. A vital part of this reorganisation would, of course, be the sales force now to be in the forefront of the drive to retain existing customers and secure new business. Sales reorganisation had been under discussion for many years but had never been implemented. Indeed, the time had now come to change from being 'demand responsive', to adopting a positive selling role. This would ensure a profitable future for the Business and employment for people in that Business.

Studies and visits to other telecommunications organisations and sales teams led to the formation of a completely new structure. A two-level office-based clerical force was set up to deal with residential and business customers, reporting to a sales team manager (STM) and a sales office manager (SOM). Field work was now to be handled by a two-level visiting force – marketing service representatives (MSRs) and marketing account executives (MAEs). They would be responsible for business customers on a 'size of installation' split, reporting to a field sales manager (FSM). Both SOMs and FSMs would report to the telephone area sales manager.

Finally, there was to be another revolutionary concept. Major account manager (MAM) posts were created to operate at national level with the Business's largest revenue-earning customers.

British Telecom had for some while paid particular attention to this group of customers and recently formed a special user group known as the Hundred Club to deal with their telecommunications needs. The introduction of MAM posts reinforced the importance of this group.

It was recognised that all these posts would require their own specialisms and a selection process for each was devised, documented and put into practice. But for some groups, the decisions were easier. Clerical officers, for years known as Sales COs, dealing with the residential market, were already in post in telephone area sales divisions as were STMs and SOMs.

Commercial officers, assigned to deal with the office-based business sector and to support the field force, were selected by interview only.

MSRs, MAEs, FSMs and MAMs were selected by rigorous tests and interviews. Jobs were advertised both inside and outside the Business to attract people who could prove they could sell. Today, the field force operates on a performance-related pay plan and members of it are provided with company cars, telephones, expense accounts and incentives. In short, British Telecom is now operating under commercial conditions and is already shifting from demand-orientation to a direct approach.

Marketing service representative Kyri Kyriacou demonstrates the Cheetah teleprinter to a customer at London's North Central Area Business Centre.

The 1980s will be an exciting and challenging period for everyone in telecommunications but particularly for British Telecom staff. The organisation now faces competition for markets in apparatus, facilities, services and livelihoods. It means a radical change to work practices and calls for a change of attitude. Staff must develop a higher degree of commercialism and become more professional in dealing with the one source of revenue – the customer.

The Business will be constantly evaluating the needs of customers, adjusting its range of products to meet changing needs and making sure that maximum customer satisfaction is given.

Two key factors will affect the future of the market place – competition and changing technology. Competition will, of course, erode British Telecom's share of the telecommunications equipment market, with many companies keen to increase their work market share with many new services and items of equipment. But the stimulation of the market will surely increase total demand at the same time. British Telecom's response must be to ensure that it has the best available equipment to complete the move from a demand-orientated organisation to a more aggressive sales and marketing-dominated business and to offer efficient installation and maintenance services.

A good response to each one of these key areas will go a long way to retaining the lion's share of an increased market place. But ever-changing technology is another matter – the speed of technological innovation requires far greater awareness of what is happening. Today, the traditional markets of computer business equipment and telecommunications are gradually coming together to form one giant communications industry. British Telecom's response must be to ensure that it has a range of equipment to meet this much wider market and to develop systems architecture in such a way that British Telecom becomes a recognised long-term supplier in the new office automation field. And, it must always adopt an aggressive sales and marketing stance and 'create' new sales opportunities – not just service demand.

Although the loss of the monopoly would seem to spell loss of sales, the reality is that with the combination of increased market demand, new technology and above all, British Telecom's newly-developed sales and marketing skills, the future is set to become an exciting and challenging one.

The use of silent time

R Murfitt and D A Cotterill

Throughout most normal telephone conversations one person talks while the other listens: in-between there are short periods of 'double talk'. In fact, measurements have shown that each direction of a circuit is usually only active for between 30 and 40 per cent of the time. This gives scope for the silent time to be used for other conversations – and that is the philosophy behind circuit multiplier systems (CMS).

Time assignment speech interpolation (TASI) was introduced to telecommunications more than 20 years ago and is still current today. Bursts of speech from any one conversation are transmitted along one of several bearer channels in a pool between the circuit multiplier terminals at two distant points. The speech bursts or signalling information, incoming to one terminal on the trunks from the exchange, are detected by speech and signalling detectors, and assigned to a bearer channel. A control message is transmitted from one multiplier terminal to the distant end so that the speech burst can be correctly connected to the outgoing trunk for that conversation.

This is a traditional method which roughly doubles the capacity of a transmission route. It is particularly suitable for speech, when advantages or multiplication factors of 2.7 or even 3 to 1 may be obtained. But the advantage is usually limited to about 2 to 1 to enable the multiplier route to carry mixed public switched telephone network (PSTN) traffic, which cannot be readily interpolated. Early TASI systems used analogue techniques for speech detection and interpolation but modern equipment is digital, giving rise to the term digital speech interpolation (DSI).

The several CMSs currently available enable both the small private circuit and bulk circuit user to take advantage of the economic advantages offered. Administrations with high-capacity PSTN routes over satellite and submarine cable systems are more likely to prefer the larger circuit multipliers such as TASI E and CELTIC 2G, manufactured by Western Electric Co in America and CIT-Alcatel in France respectively. Both of these carry 240 trunk circuits over 120 bearer circuits at a cost of about £3,000 for each of the extra, 'derived', 120 trunk circuits. That figure compares with the capital costs of around £30,000 for each circuit in a transatlantic submarine cable system such as TAT7 (see *British Telecom Journal*, Summer 1982) and about £3,500 for one in a southern North Sea cable. These larger multipliers are simple to install in a repeater station and do not involve long planning and implementation lead times.

Smaller systems like COM2, PLC-1 and TLD, manufactured in America, Canada and Israel respectively, are available to the private circuit user and can be used by administrations to expand small PSTN routes cheaply or as an expedient. Again these systems can be quickly installed, either on the customers' premises to interface with a PABX or in an exchange complex.

The derived circuit cost for these smaller systems is slightly higher than for the larger ones but, when compared with the rental for a circuit across the Atlantic, they are highly competitive. These systems offer a small configuration of five trunks on three bearer channels and then increasing capacity options to their maximum configurations of 31 on 16 for COM2 and 48 on 24 for TLD and PLC-1.

TASI systems were first used between London and New York/Montreal on early transatlantic cables such as TAT1, CANTAT1 and TAT3 and it is a measure of success for the multiplier that the last system, 72 trunks over 36 bearers, was switched off earlier this year. Another early system, TASI B, is still operational over Pacific Ocean cables between Vancouver and Sydney.

So how does the modern system work? A speech burst arriving on an input trunk is first converted into digital form by the analogue/digital (A/D) converter and stored while the speech detector decides whether it is a valid speech signal or background noise. This process takes a finite time, albeit milliseconds, but in the analogue system in which speech could not be stored, the fronts of words were 'clipped' while the direction took place. Digital storage eliminates the clip.

'Freeze-out' occurs when there are not enough bearer channels to meet the demand from the trunks and so results in speech loss. If speech only is transmitted it is unlikely to occur but CMSs must be transparent to anything put randomly onto the network. This includes data, facsimile and signalling tones which continuously transmit demanding a permanent trunk-to-channel assignment for an extended period. The number of bearer circuits available in the pool is reduced for the transmission of speech bursts. A high proportion of data calls or a high incidence of signalling can therefore result in freeze-out and some trunks being busied back to the exchange to counteract it by denying further access to the system.

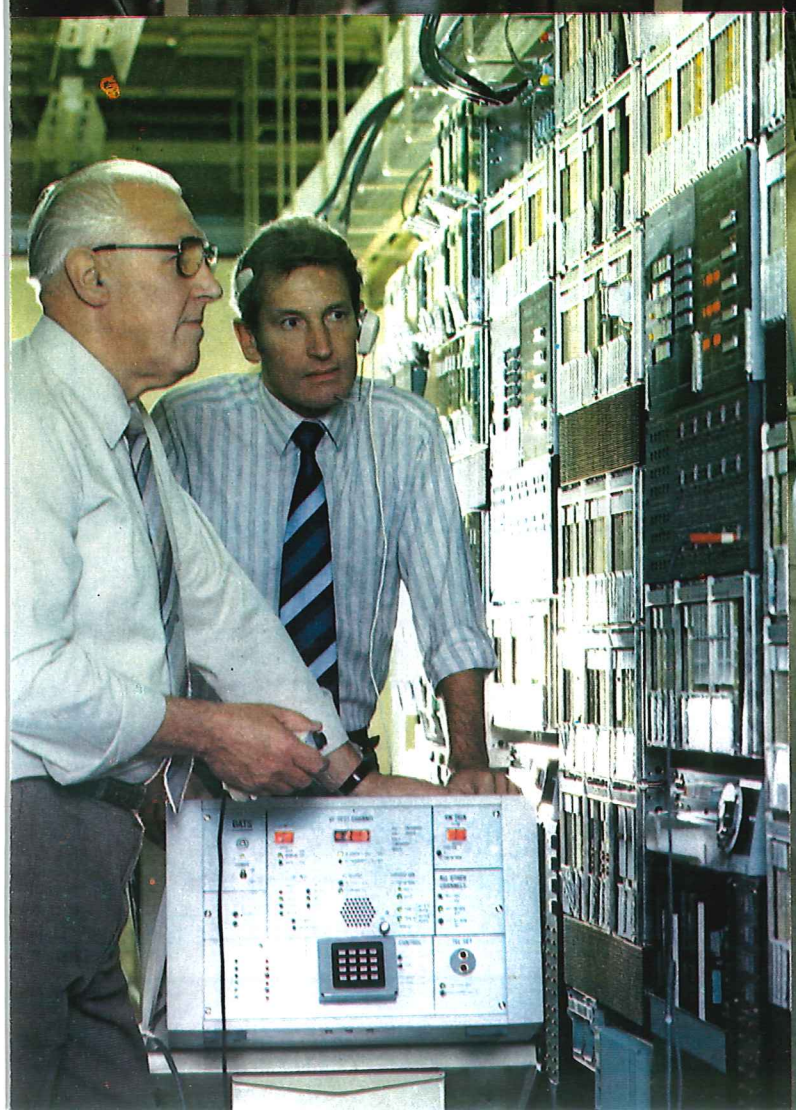
Signalling the assignment information between multiplier terminals is the fundamental difference between the larger (TASI E and CELTIC 2G) and smaller (COM2 and TLD) systems. But there is always an exception, in this case PLC-1. The larger systems and PLC-1 use common channel signalling between terminals. In the case of TASI E, three of the 120 bearer channels are used exclusively for control messages and the 240 trunks are interpolated between 117 bearer channels.

Top left:
The TASI-E equipment in Stag Lane is capable of self-diagnosis. TOA John Windsor looks at the print out from a dedicated printer to check the number of working channels.

Top right:
Technical officer Dalip Jassal telephones his opposite number at the New York-based TASI-E terminal to check a faulty channel.

Bottom left:
Assistant executive engineer Len Tytherleigh discusses the faulty channel with John Windsor before connecting the digital access test set used to check tones and speech levels.

Bottom right:
These racks contain the analogue/digital interface cards vital to TASI-E equipment. Robin McFie checks voltages on one of the cards.



CELTIC 2G uses a similar arrangement and PLC-1 reserves one on its 24 bearer channels for use as the control data channel and interpolates 48 trunks between 23 bearers. COM2 and TLD use header signal methods with COM2 sending a multifrequency tone in front of the speech burst and TLD a binary word. For these latter two systems, all bearer channels are available for interpolation of speech.

For network planners, two problems become apparent. The number of multiplier systems, and their type, are connected in tandem so increasing propagation time over the route and the likelihood of freeze-out. There is also the possibility that one multiplier system may be sandwiched between another so negating the usefulness of the one in the middle.

During the 1960s and most of the 1970s, TASI A, on the London to New York and Montreal routes, and TASI B, on the London and North America to Sydney route, were the only circuit multipliers in use. But with the advent of DSI, providing freedom from distortion such as speech clip, the technique of multiplication has become much more attractive. At present, there are systems working on both cable and satellite routes across the North Atlantic, from the UK to the rest of Europe, over satellite circuits to the Indian Ocean and even systems on open wire carrier in Africa. With such proliferation, the increasing likelihood of systems working in tandem, the associated problems of increased freeze out, and increased propagation delay become altogether much more apparent.

British Telecom International and the American Telephone and Telegraph Company (AT&T) brought the first 240 trunks on 120 bearer channel TASI E system into service on a North Atlantic cable route last November. That system works to New York. It has been followed by two further TASI E systems working to White Plains and Pittsburg. Next year, TAT7 will be brought into service across the North Atlantic and the ANZCAN Pacific cable system between Vancouver, Hawaii, Fiji, Norfolk Island, Sydney and Auckland, New Zealand will also be commissioned. Demand for circuits is such that all cable routes across the North Atlantic will require equipping with large CMSs, to feed the North American continent and onward through ANZCAN to Australasia.

Although the various multipliers will work efficiently over satellite routes, provided a few precautionary engineering factors are taken into account, the satellite organisations have developed their own multiplier which works with an assignment system called TDMA (time division multiple access). The full title – TDMA/DSI (digital speech interpolation) – signifies a system which accepts 240 terrestrial circuits per interface module, and routes them over 128 satellite channels to any one of a number of required destinations. TDMA/DSI is totally digital and should be introduced into the Intelsat and Eutelsat networks during 1984. It will also be installed at the relevant satellite earth stations.

Digital transmission systems designers are now becoming more ambitious and forecasting advantages of 5:1 and even 8:1. These figures will be achieved by combining DSI with digital bit reduction coding techniques such as adaptive differential pulse code modulation (ADPCM). The ADPCM component can be used to reduce the standard 64 kbit/s digital speech channel to 32 kbit/s, 24 kbit/s or 16 kbit/s to achieve 2:1 to 4:1 for combination with the 2:1 DSI advantage.

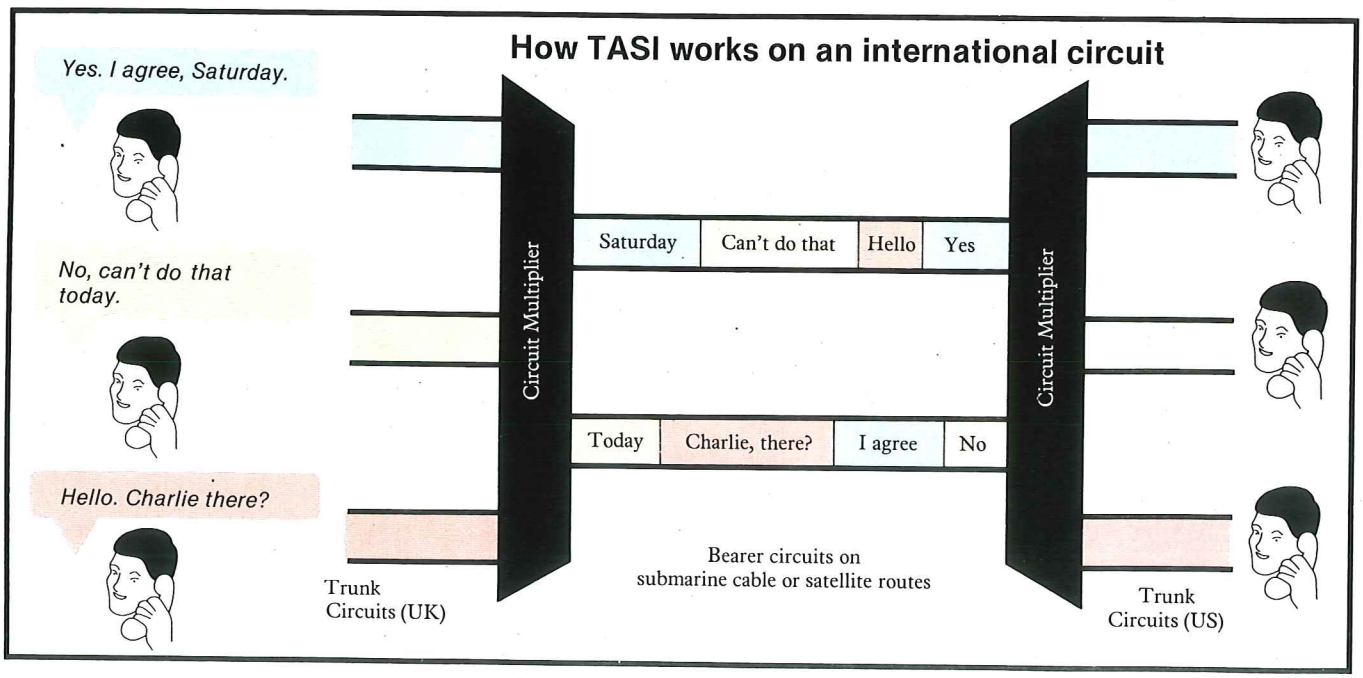
Alternatively ADPCM could be used independently to provide circuit multiplication without using an interpolation technique. Two 32 kbit/s channels could be transmitted over a 64 kbit/s channel and each would remain as a permanently connected dedicated channel for exclusive use. For smaller routes such an ADPCM unit alone could be used to provide 2:1 multiplication. For larger routes the DSI/ADPCM combination might be employed to provide around 5:1 multiplication. And current discussions for routes over the digital optical fibre transatlantic submarine cable system, TAT8, include consideration of 5:1 CMS at the metropolitan terminals from the outset.

Currently, there appears to be scope for using CMSs in the international network, particularly by administrations for the PSTN. But customers' needs may well become so sophisticated in the future that a dedicated 64 kbit/s circuit has to be provided for both private and public networks. Ⓣ

Mr R. Murfitt is head of British Telecom International's network integration and control division.

Mr D. A. Cotterill is an assistant executive engineer in the same division responsible for new systems integration.

British Telecom Journal, Autumn 1982



On the Lightlines...

The world's longest optical fibre telephone cable came into service during the summer between London and Birmingham, the busiest trunk route in Britain. This is the latest addition to British Telecom's 'Lightlines' optical fibre network. Optical fibres are hair-thin strands of glass carrying messages and information as pulses of light.

British Telecom began laying the 204 kilometres (128 miles) of optical fibre cable in October last year. After only nine months the cable has begun carrying calls between the country's two major business centres.

Announcing what is a world-first, Sir George Jefferson, Chairman of British Telecom, said: "This is a further step to give the nation's businesses the full range of modern facilities they demand, well ahead of our competitors. It is also an essential part of the foundation for the information technology revolution that will transform the whole of society during the latter part of this century".

The glass used in optical fibres is so pure that a block 20 kilometres (12 miles) thick would be as transparent as a window pane. Each hair-thin strand can carry up to 2,000 simultaneous phone calls and enough strands to carry 10,000 calls would pass through the eye of a needle. Because the message is carried as digital light pulses, it means that more and different types of information can be carried, faster and with better reception.

Optical fibres are immune to electrical interference, eliminating crosstalk and noise, and allowing perfectly clear transmission.

Traditional copper cable needs the signal boosted every two kilometres (just over one mile) but with optical fibres, the signal needs boosting at less frequent distances. The new cable is the first in the UK to operate at long wavelength, which enables the boosters to be placed ten kilometres (six miles) apart. This greater distance between boosting reduces the number of items likely to need maintenance.

Optical fibre cables also take up less room than copper cable, allowing more calls to be carried down the same cable duct. This and the fact that the raw material – sand – is cheap means lower costs for British Telecom which gives greater ability to hold down prices.

The London to Birmingham link is 129km longer than any previous British Telecom optical fibre link and uses light-emitting diodes (LEDs) instead of lasers as light sources. The cable is made by BICC Telecommunication Cables and contains eight fibres, each 125 micrometres in diameter (about 0.005 inches). Plessey Telecommunications has supplied the associated electronic transmission equipment which uses high-radiance LEDs emitting light at a wavelength of 1.3 micrometres, compared with a maximum of 0.90 micrometres in earlier systems.

Initially, two fibre pairs in the cable have been brought into service. These operate at 34 Mbit/s, each able to carry up to 480 phone calls simultaneously. Next year, the other two pairs will be used for 140 Mbit/s operation, to give each a 1,920 circuit capacity. Ⓣ

All over the country, cable laying teams are installing Lightlines, which provide cheaper, more reliable communications.

British Telecom Journal, Autumn 1982

THE OPTICAL FIBRE STORY

1965 Major research activity began into use of optical fibre in public communications networks.

1977 Europe's first public phone calls sent over an optical fibre link using the British Telecom Martlesham-Ipswich experimental link.

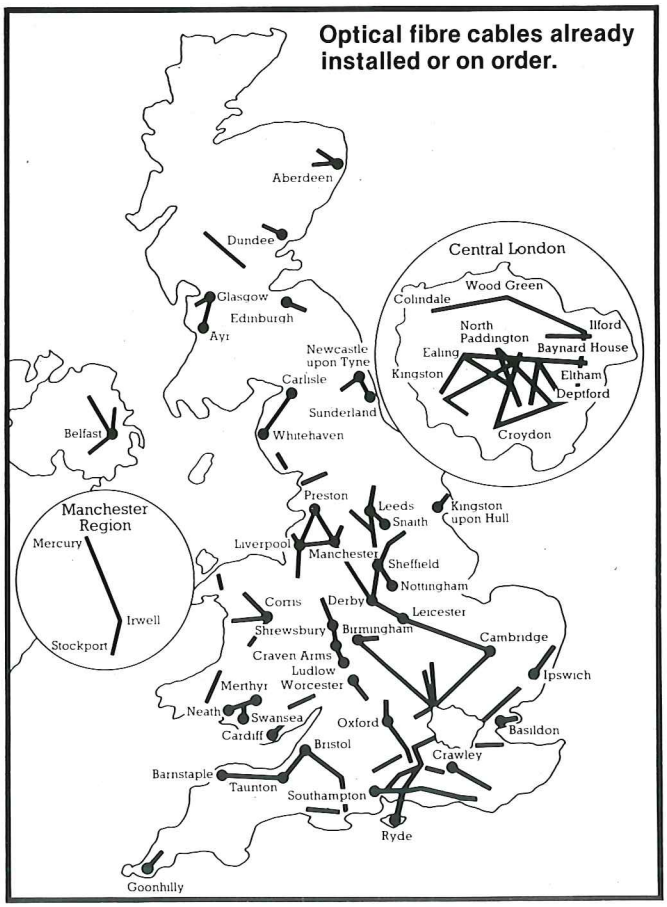
1979 First stage orders are placed for the world's most comprehensive optical network totalling 3,600km of fibre and associated transmission equipment.

1980 First operational link goes into service between Brownhills and Walsall in the West Midlands.

1981 Second stage orders placed for 6,400km of fibre and associated equipment including the first order for a monomode system.

1982 The world's longest optical fibre link to date, using the advanced technology of long wavelength operation, has been brought into service.

The third stage of orders of £10½m worth of fibres and associated equipment has been placed. This brings the total length of fibres installed or on order to 26,000 kilometres (16,250 miles), all of which will be installed by summer 1985.



The plaque presented to all crew members who served in the South Atlantic during the Falklands conflict.

Right: **On a clear day in the South Atlantic a Sea King helicopter prepares to land on *CS Iris* to pick up vital stores.**

CS Iris in the Falklands

The Ministry needed to use the 3,800 ton cable vessel *Iris* as a despatch ship to carry stores, mail and military personnel from the security of Ascension Island to the Task Force located on and around the Falkland Islands. Volunteers among Marine Division's complement were not hard to find, and on 27 April, *CS Iris* left Southampton bound for Devonport where she received extensive modifications including a strengthened 30-ton helicopter deck. Two Oerlikon anti-aircraft guns were also mounted on the ship.

Even as the ship slid silently out of Devonport two days later, the crew were receiving instructions from naval personnel on their newly-installed equipment. But the journey to Ascension had its drama. A container of helicopter fuel caused havoc by spilling over deck during a sea exercise. Other problems created by the weight of the newly-installed helicopter deck were eventually overcome by the time *CS Iris* arrived and anchored at Ascension Island. Immediately work began, loading stores by helicopter and taking on military personnel. For *Iris* the war had begun.

At Ascension, the last items to be taken on board were two 'Snowcat' tracked vehicles destined for use by the Royal Marines in South Georgia. As a giant Chinook twin-rotored helicopter manoeuvred into position in the failing light of the day, one of its massive blades sliced into the 10cm radar scanner. Both the scanner and its associated motor were demolished, resulting in delay until an inspection could be carried out to ensure no further damage had occurred.

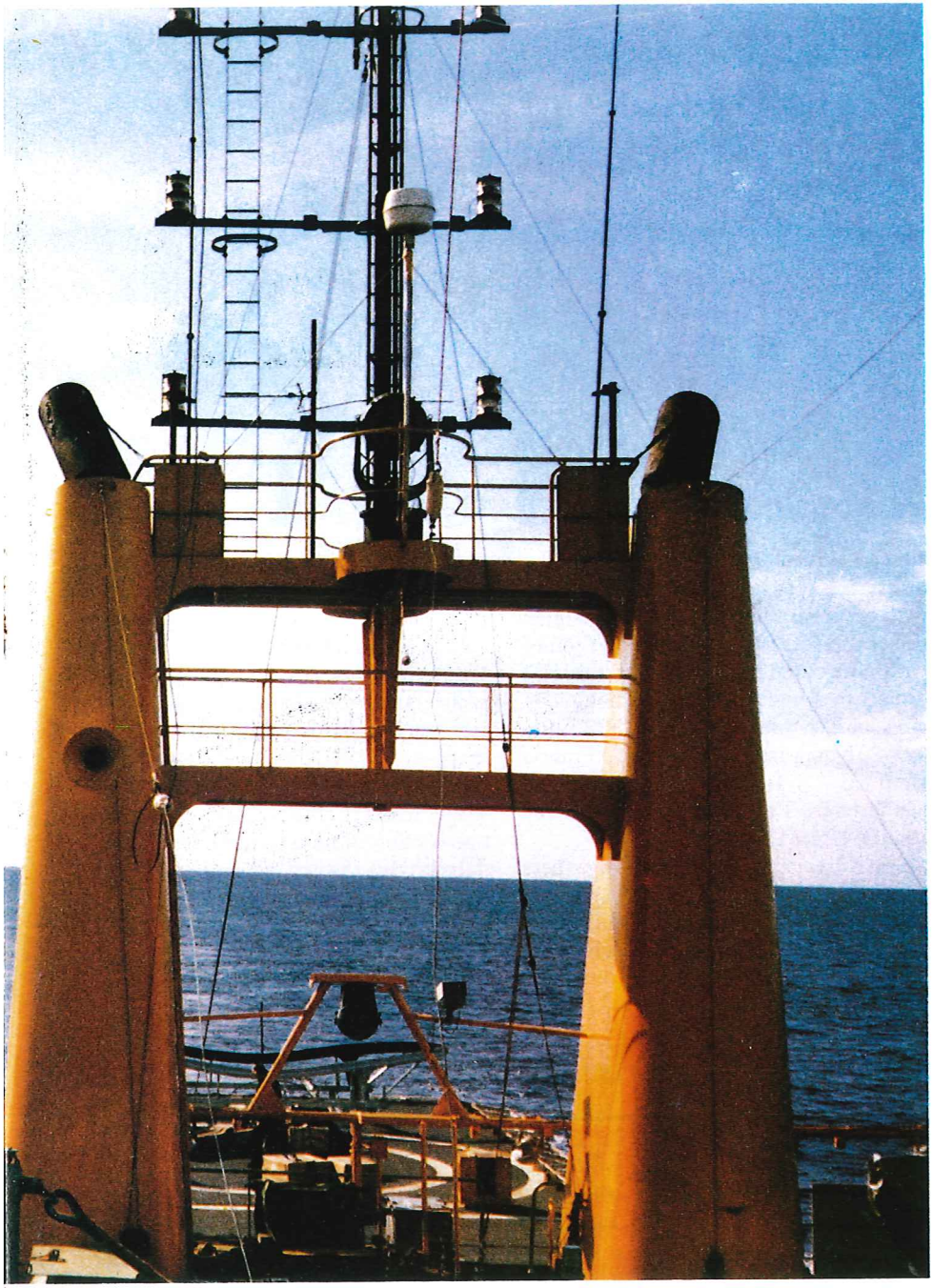
With a full cargo and a detachment of marines, *Iris* at last set sail for the South Atlantic. Apart from a 24-hour submarine alert, this second leg of the journey was uneventful, and on 25 May, *Iris* tied up on the King Edward Jetty at Gritvyken in South Georgia. Immediately the marines were transferred to *HMS Endurance* and stores for the garrison there were unloaded. No shore leave was allowed as the area had been booby-trapped by the Argentine troops.

The following day, *Iris* was instructed to sail for the remote whaling station of

Just three days after returning from an A
International's marine division based at Soutl
Defence. Its message . . . to take up the servic
Falklands conflict'. It was the first time since
British Telecom vessel had been needed for a
Captain Alan Fulton who received the OBE f
the story . . .

Capt Alan Fulton OBE.

***CS Iris* prepares to pick up scrap metal at S**



rctic charter, the head of British Telecom
ıampton received a telex from the Ministry of
ces of cableship *Iris* 'for operations during the
the Second World War that a Post Office or
ctive service. Here, the master of the *CS Iris*,
ollowing the South Atlantic campaign, tells

outh Georgia.

One of the many happy reunions when original *CS Iris* crewmembers returned to the UK in July.

Stromness where she was to pick up steel plate and angle iron left by the defeated troops. Indeed, this was the very same metal which had originally brought the Argentine dealers to the island earlier in the year – the event which precipitated the Falklands war. Ironically, this metal was now to be used to patch up British ships damaged in action.

By the following afternoon, despite problems caused by half the jetty collapsing, *Iris* returned to Gritvyken to transfer troops from the *QE2* to the *Canberra*. On arrival, orders had been changed and *Iris* headed for the main Task Force.

In addition to Capt Fulton's receiving the OBE, chief steward Dick Barrett was awarded the BEM.

Iris joined the main fleet on 30 May and began off-loading stores and mail to the *RFA Fort Austin* in deteriorating weather conditions with gale force winds and poor visibility. And, to add to the difficulty of these operations, the ship came under air attack four times but managed to avoid damage. On return to Ascension via South Georgia, *Iris* encountered fog and icebergs. With the use of radar limited to a few seconds every 25 minutes, careful calculations were vital.

By now, however, the ship was running short of fuel and an attempt to replenish at sea in the dreadful conditions of the 'Roaring Forties' from the Fleet Auxiliary tanker *Appleleaf* ended in failure and left no alternative but to wait for better weather further north.

Reaching Ascension Island on 19 June, *Iris* underwent minor repairs to her engine, and before long, loaded to the gunwhales with stores and passengers, headed south again to rejoin the Task Force. The passage was one of the worst with winds of more than 100 knots and seas up to 55 feet high. She arrived on 4 July and this time headed for the Falkland Islands where she unloaded stores and equipment in San Carlos Water and at Port Stanley. She subsequently returned to Ascension where on 23 July, most of the crew who had been with her since her departure from Devonport were flown home for well-deserved leave. Another group of volunteers had already been flown out to provide relief.

CS Iris is due to arrive back at Southampton in late November. She will have been at sea for more than six months and will have sailed more than 20,000 miles. And almost as soon as she has docked preparations will be underway for her next assignment . . . which is bound to be a little less adventurous. Ⓣ

Sharing network costs

JDW Arthur

At present, most network planning methods consider individual parts of a network in isolation and design each part to meet a set standard of service. This is a piecemeal approach that results in a network which, from the customer's point of view, creates varying standards of service from place to place. It is also possible that the network may not be the cheapest one for the standards of service offered.

Because of the enormous amount of capital tied up in a modern telecommunications network, it is important to minimise its cost – particularly in a competitive environment – and this can be done by looking at the network as a whole, considering both the switching and transmission networks together and imposing a uniform overall grade of service.

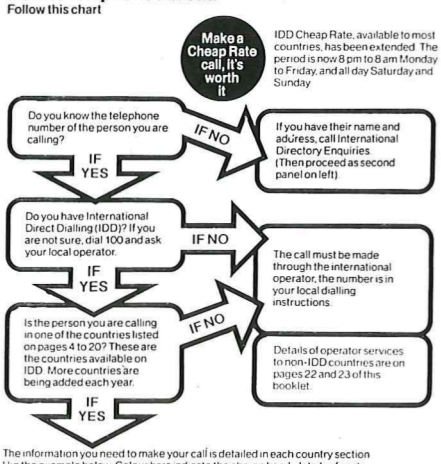
A planning method which achieves these aims is bound to be complex and requires much computer time. It is essential therefore that advanced mathematical techniques are used in its construction.

Senior telecom superintendents David Greenhop (seated) and Ron Campbell run through a French administration-prepared computer program with a view to implementing some of the ideas on to British Telecom machines for possible applications in the network.

The amount of work involved in such a task makes it attractive to share resources with other administrations having similar needs and so British Telecom has joined with nine other European countries on a project to devise a suitable planning tool. This joint venture is known as COST project 201 and involves Finland, France, Germany, Ireland, Italy, The Netherlands, Portugal, Sweden, Turkey and the United Kingdom.

Eleven researchers representing these countries (Italy has two members) form a task force which is working for three years to develop a set of algorithms which can be

How to telephone abroad
Follow this chart



The information you need to make your call is detailed in each country section like the example below. Colour bars indicate the charge band, details of costs are on a separate sheet

A popular example of an algorithm used in a current international telephone guide.

used by any of the participating administrations to produce computer programs to design the best and most economical network for their own country. The project is aimed at producing algorithms rather than computer programs because the computers used by the different administrations vary and complete rewrites of programs written to suit a particular machine would be required by almost all parties. When the procedure has been programmed it should not only supersede many existing planning methods but also enable British Telecom to test cheaply the cost and security of various possible network structures.

The project was formally inaugurated in 1980 and should be completed next year. Unlike some international projects where each country continues its normal research but shares results with other participants, COST 201 allows the work to be subdivided and the tasks distributed between members of the task force. Duplication of effort is thus avoided but it is essential with this method of working to ensure that the project has tight overall management control.

This control rests with a management committee consisting of one or two representatives from each participating administration. The committee meets about every three months to review progress and to set a work plan for the task force to carry out before the next meeting. In addition there is an annual seminar at which the management committee and task force discuss problems and decide future work and also compile an annual report for submission to the Commission

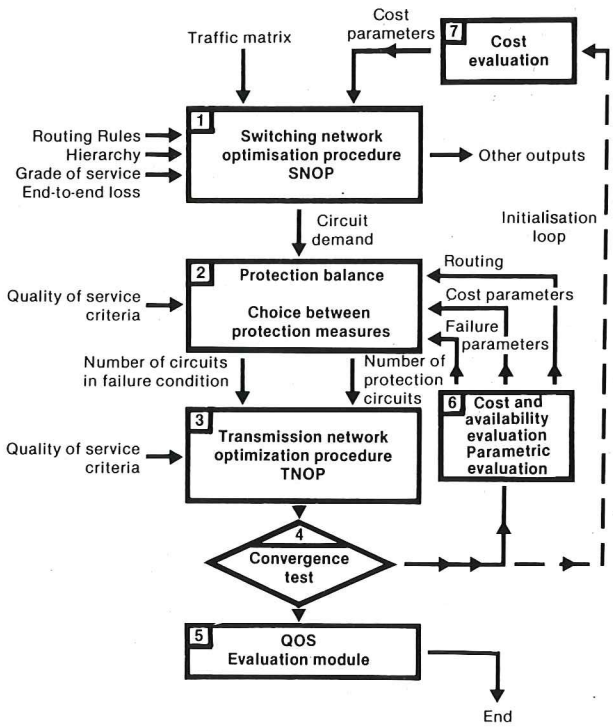
Nico Noort from the Netherlands administration guides a recent meeting of the task force and management committee convened annually to hammer out problems and decide future work.

COST is a committee for European Co-operation in Scientific and Technical Research. It was originally set up by the EEC for research into subjects such as meteorology and pollution which were too expensive or too wide-ranging for individual countries to undertake in isolation. Participation in projects is open to all 19 European countries – not just those who are members of the EEC.

Representatives of the governments of each EEC country form the Committee of Senior Officials (CSO) which decides on areas in which research should be carried out. It also determines which countries are interested in collaboration in each particular field and then prepares the legal agreements necessary to initiate a project. The UK is represented on the CSO by the Department of Trade and Industry.

For each major area of research, a technical committee is set up to determine projects that need to be tackled and to advise the CSO. The Technical Committee – Telecommunications is responsible for all the projects in telecommunications and has a representative from British Telecom.

All COST projects in telecommunications are coded COST 2xx. Apart from COST 201, British Telecom is also participating in COST 202 on digital local networks, COST 203 on component reliability, COST 205 on radio propagation above 10 GHz, COST 208 on optical fibre systems and COST 211 on video redundancy techniques.



Flow chart of overall procedure

in Brussels. A project evaluation and review techniques (PERT) chart for the whole project has been compiled to enable the management committee to check that satisfactory progress continues to be maintained.

Before the project was formally launched, agreement had been reached on objectives and terms of reference. Formal written guidance for the task force was set out in three 'black books' on terms and definitions, quality of service, reliability and costing methods and network models. These 'black books' are in the working language of the projects, English, and were published by British Telecom who also provide the secretariat. They have received a wide circulation both within and outside Europe and have been useful in standardising terminology in their particular field.

The terms of reference for the task force were to produce a procedure which would take account of a future mixed analogue and digital network; an existing network; a network of up to 600 switching nodes and a similar number of transmission nodes; fixed routing patterns, including automatic alternative routing; resilience to equipment failures and traffic overloads and modular provision of plant.

To simplify the problem, it was decided that the network would be optimised for one date – nominally 20 years ahead – rather than continuously over a period. Costs are calculated using a present value of annual charges method.

A unique feature of the project is that quality of service parameters can be input and the cost of different methods of protecting the quality of service during breakdown conditions calculated. Methods of protection include standby transmission links, diversity of links, automatic alternative routing, deliberate overprovision and different types of network structure. The algorithms being derived will enable planners to assess the cost and effectiveness of different strategies for protection of service.

It is necessary to test the algorithms as they are developed and this is done by programming and testing by computer. The French administration provides the computing facilities for the whole project at the Centre National D'Etudes des Telecommunications (CNET) in Paris and task force members program their own modules remotely using access via the public switched telephone network. Week-long task force meetings normally take place at CNET about every two months to enable members to discuss problems and arrange for module interfaces to be defined.

An outline flowchart for the procedure is shown above. It will be seen that the switching network and the transmission network are optimised separately although there are feedback loops between them. Switching network optimisation procedure (SNOP) and transmission network optimisation procedure (TNOP), contain the bulk of the work of the project.

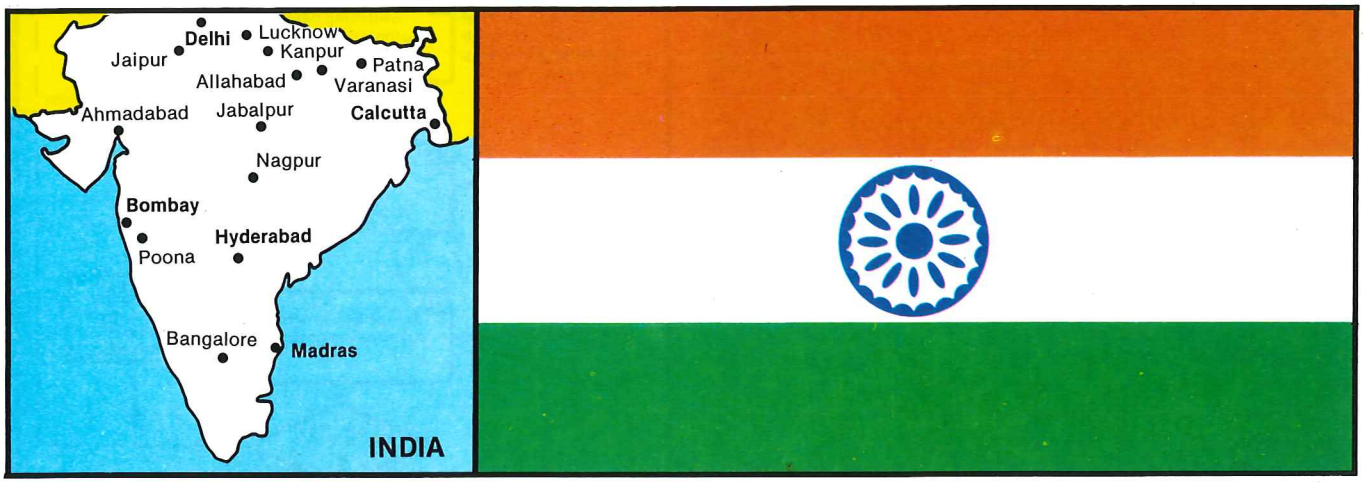
The task force was split into subgroups to tackle these areas separately and they meet independently as necessary. Within both SNOP and TNOP, there are a number of modules each of which is the responsibility of one of the task force members.

A large number of inputs and outputs are required for the procedure and a major problem has been to ensure that the data in each module is structured in such a way that the inputs and outputs from and to other modules can be defined so that work can continue independently. An indication of the complexity of the procedure can be gained from the fact that there are 60 different inputs in the form of data and parameters and that some of these inputs may have up to 400,000 values. It is important therefore, that the method of inputting data is as easy for the users of the procedure as possible.

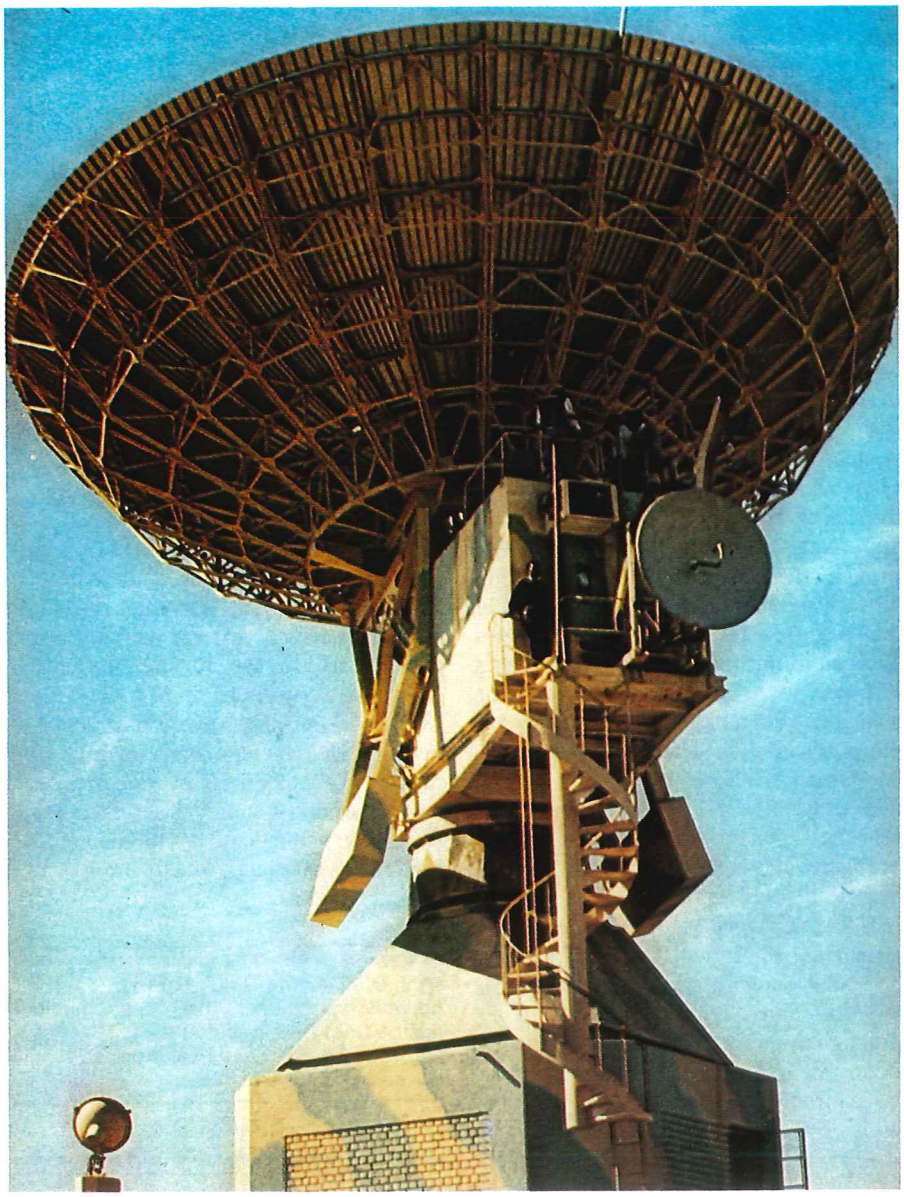
Although the effort involved in the project is high, potential benefits from accurately designing the least expensive network for a known quality of service are too great to be ignored and completion of the work next year is now keenly awaited by all concerned.

Mr J. D. W. Arthur is head of the network management group responsible for the Cost 201 project in the Network Planning and Performance Division of Inland Division.

British Telecom Journal, Autumn 1982



After the Raj...



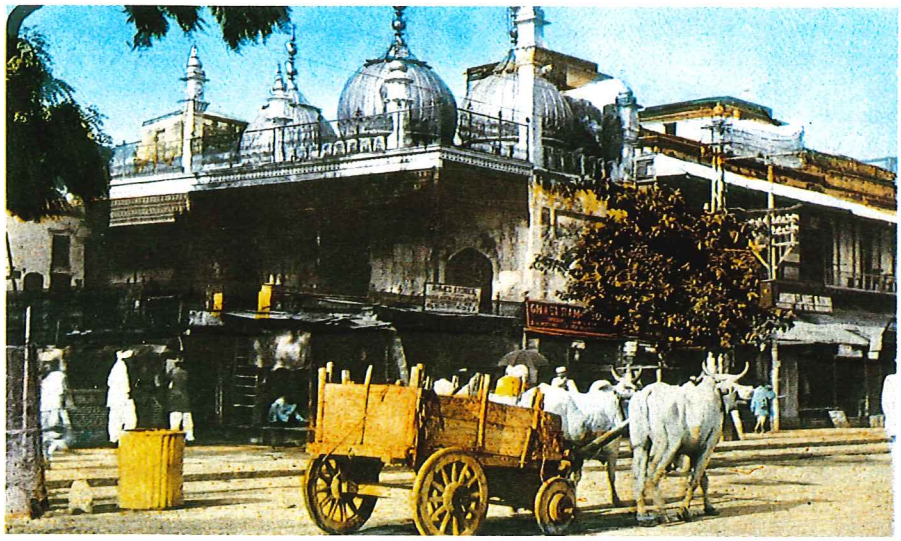
This, the eleventh in our series on overseas administrations, looks at the complex problems of developing communications in the sub-continent of India.

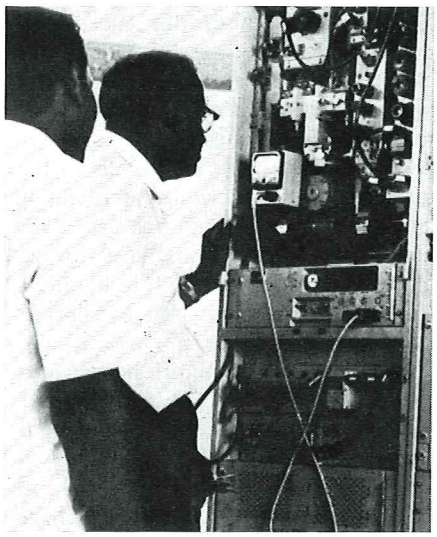
India is in many ways typical of the third world. In its struggle to develop its economy, the national government has laid great emphasis on all forms of communications, but although the end of the Raj had left the country with excellent rail and road links, telecommunications had been badly neglected.

The first telegraph link had opened in 1851, and the telephone service in 1882, but by Independence in 1947, only 320 telephone exchanges serving 86,000 connections had been built. The following 30 years have seen remarkable progress and now nearly 8,000 exchanges serve nearly three million telephones. But with a total population of 660 million inhabitants, growth potential is clearly still enormous.

The Indian administration is organised into two departments – the Overseas Communications Service and the Indian Posts and Telegraphs Department (P&T) – both of which are responsible directly to

Satellite earth station at Ahmadabad in north west India.





A transmitter and receiver equipment bay at the Satellite Communications Training Centre, Ahmadabad.

the Minister for Posts and Communications. The P&T Board consists of the Director General, two members for operation and planning of telecommunications, two for posts, and one for finance and administration. India is divided for telecommunications operations into 37 territories, each handled by a general manager. Additionally the four large metropolitan areas of Delhi, Bombay, Calcutta and Madras are organised separately and, like London, have area sub-divisions.

Some 700,000 workers report to P&T, of whom about a third – roughly the same number as British Telecom – work in telecommunications. Every year the Indian P&T trains 15,000 new recruits – operative staff at 25 centres and supervisory staff at 14 centres. Initial training for management is carried out at Jabalpur and in-service training at the Advanced Level Telecommunications Training Centre (Altcentre). The Altcentre was set up in 1975 as an ITU development project, and has up-to-date facilities capable of meeting the training demands of rapidly-changing technology.

Developments have been hampered by problems in urban and rural areas, where, because of climatic and demographic difficulties, a consistent service is almost impossible to provide. For the past 30 years much work has gone into increasing the efficiency of the national trunk network through gradual automation. Major routes have been converted from open wire to microwave and coaxial, often with mutual support in the case of routes between primary centres. Strowger accounts for 70 per cent of switching equipment, crossbar 29 per cent, while one per cent remains manual.

Subscriber trunk dialling (STD) began in 1960 and this has been expanded to cope with over half of total trunk calls on 150 routes between 30 major cities. Main urban difficulties stem from demand outrunning supply. Currently of 600,000 applicants, some have been waiting as long as 15 years. This has resulted in directories carrying lists of pending applications and often several firms have to use the same telephone. As a result, traffic per line is high, holding time is low and repeat attempts high.

But if problems exist in urban areas, rural areas pose difficulties all of their own. Lack of concentrated demand means that a village is best served by one public call office telephone, and the current total of 10,000 is expected to double in the next five years.

India's climate causes further problems, with monsoons damaging unpressurised cables and washing away roads, consequently damaging coaxial cables. And in the hot dry weather, dust can damage electro-mechanical equipment. Although the average out-of-service time has been reduced to one hour per 100 system kilometres per month, national fault complaint rates are running at 40 per 100 telephone stations per month, with an average fault duration of 5.4 hours per month. Perhaps it is not surprising that the telegraph service continues to expand, with revenue 50 per cent higher than that of telex. Today the telex network consists of 20,000 connections, and demand for fast data transmission is now beginning to accelerate.

The general trend in Indian telecommunications is towards enlarging the telephone service, particularly for industry. To stem telephone demand, the P&T has turned to fixed tariff imposition. Application forms are priced at 50p each, and two options are available in terms of fixed tariff payment. The first, entitled *Own your telephone,* requires a five-year minimum commitment and a downpayment of £250. The second asks for an advance payment of £50, but the applicant may give up his telephone after three months.

This category has provision for special treatment of applicants involved in service to the public good such as medical or industry. The installation charge is £5, and a quarterly rental of £7.50 is rebated by £3 for subscribers in the first category. Misuse of the application system is widespread, despite the appointment of a 'vigilance officer' by the administrative board.

Call tariff structure also reflects the need to reduce demand, particularly in the trunk network. In the case of the delay trunk service on which calls are booked with the operator and reverted to the caller, there are three classes of call: 'lightning' at eight times 'normal' cost, 'urgent' at twice normal cost, and 'ordinary' at normal cost, all of which are restricted to six minutes' duration.

In the demand trunk service, available on some busy routes by dialling a special code to the operator, all calls are charged at urgent rates with no restriction on duration. For both the 'delay' and 'demand' services there is a concessional tariff at half the ordinary rate on week nights and Sundays. A similar cheap night tariff period operates for the STD service.

Trunk call steps, of which there are six ranging from 20km to over 1,000km, are

designed to subsidise shorter distance calls. This recognises that most rural subscribers who generally need short distance calls have limited funds. A trunk call over 1,000km for three minutes for example costs ten times as much as a call in the lowest charge step. Local calls are not timed and the charges which are about 3p per call vary depending upon use – the more calls made, the more the charge per call. STD charges are slightly more expensive than the ordinary trunk call rates but markedly cheaper than 'urgent' calls. Operator directory enquiries, the time, emergency and a variety of other information services are available in all automatic exchanges.

In its plans for the future, the P&T has an ultimate objective that no one should have to walk more than two miles to a telephone, which should bring about long-term economic benefits and improve the welfare of the population, most specifically in the rural areas. In the face of the relatively high capital investment required to achieve this objective, the P&T recognises that it cannot ignore cost factors, which will obviously influence the choice of network and switching technology for the expansion of the rural network.

Here the Indian Telecommunications Research Centre (TRC) is playing a useful role by developing a series of stored program control exchanges, including a relatively small one for rural use. A 1,000 line field trial unit was opened for public use in Delhi in 1980. Other versions already exist at the Altcentre for evaluation and software development.

Staff at work in New Delhi exchange.

Assembling telephones inside an Indian Telephones Industries factory at Bangalore.

To meet the requirements of the five-year plan, ending next year, expansion of manufacturing and imports of digital equipment must be undertaken. World Bank aid has been made available to cover half the import costs of this equipment which is vital for technology transfer. Other projects include the establishment of a public data network, expansion of the national network by new microwave links, introduction of electronic switching for local, trunk and telex exchanges, and provision of jelly-filled and pressurised cables.

But by far the most ambitious project is the proposed addition of a third dimension in the form of a domestic satellite network providing telecommunications, television and meteorological services to remote areas beyond the reach of terrestrial media. The two satellites required, known as Insat I and II, will be launched at the end of this year and in 1983. The transponders in the satellites will be able to provide from 6,000 to 8,000 two-way telephone circuits as well as television channels. They will link 29 stationary and six mobile earth stations with half the fixed stations in remote areas.

Intelsat satellites already handle international services but the Insat scheme with its enormous potential for communications, education and entertainment, will doubtless have a profound effect on Indian rural development and therefore on the sub-continent as a whole.

The Indians certainly have had to develop very quickly to attain the level of service that they have now, and the way that they are approaching the future, suggests that their telecommunications system will continue to develop if investment can be met. It is, however, a sobering thought that even if by the year 2,000, India reaches a standard of telecommunications similar to that of the UK today – itself a tremendous achievement requiring installation of more than 160 million connections – she would still be something like 20 years behind the developed world!

The authors – **Mr P. H. Dabbs, Mr J. J. E. Swaffield, Ms C. M. C. Aust** and **Mr I. Sarwar** – are all members of the international comparisons group in the Service and Performance Department of BTHQ. They acknowledge the help of **Mr O. P. Sellars,** a former member of the same group.

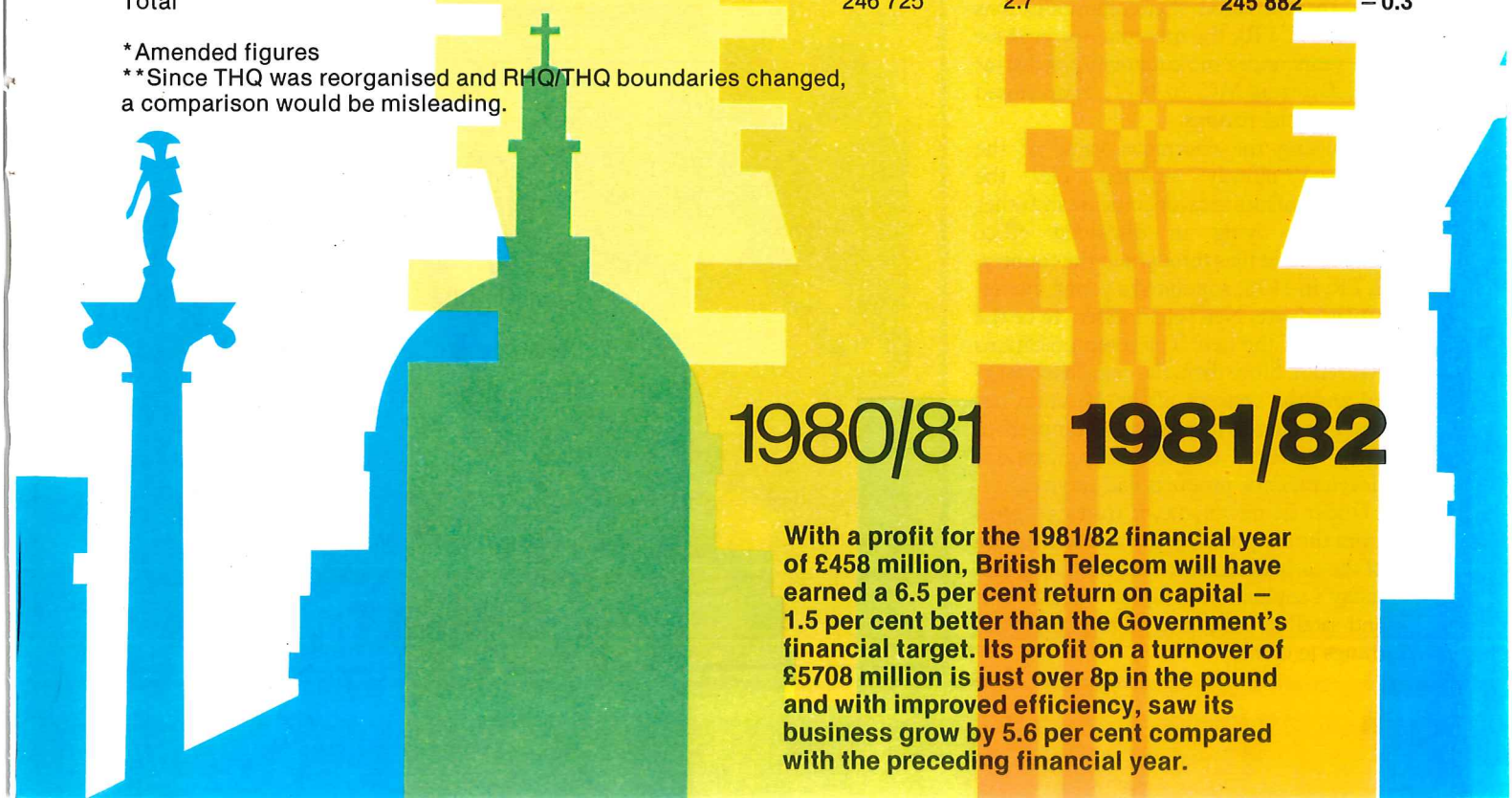
British Telecom Journal, Autumn 1982

The year in figures

A review of British Telecom progress during 1981/82

	Result	% Growth over 1979/80	Result	% Growth over 1980/81
Telephone service				
Size of system				
Total working connections	18 418 000	4.7	18 962 000	3.0
Total working stations	27 870 000	4.2	28 450 000	2.1
Call office connections	77 000	0.0	77 000	0.0
Shared service connections	1 350 000	– 10.0	1 111 000	– 18.0
Growth of system				
Net demand for connections	1 558 000	– 18.0	1 393 000	– 10.6
Net supply of connections	1 763 000	– 8.8	1 578 000	– 10.5
Penetration				
Stations per 1000 population	498	4.4	511	2.6
Traffic				
Inland effective calls: trunk	3 335 000 000	2.4	3 446 000 000	3.3
Inland effective calls: local	16 840 000 000	1.4	17 360 000 000	3.1
Continental: outward calls	79 467 000*	5.6	86 352 000	8.7
Intercontinental: outward calls	36 971 000*	19.1	45 806 000	23.9
Telephone usage				
Calls per connection	1 127	– 4.2	1 120	– 0.6
Local exchanges				
Total	6 338*		6 319	
Strowger	4 421			
Crossbar	537			
Mixed Strowger/crossbar	41			
Electronic	1 305			
Mixed Strowger/electronic	34			
Telex service				
Size of system				
Total working lines	90 000	4.9	92 576	2.9
Traffic				
Inland calls: chargeable			91 200 000	
Inland calls: effective			95 000 000	
External outward numbers of minutes	226 215 000	7.6	244 538 000	8.1
Telecom staff (part timers count as half)				
Telecom HQ	3 786	**	4 029	6.4
Executives	35 381	**	34 055	– 3.9
Regional HQ	14 082	**	13 690	– 2.9
Telephone Areas	193 476	**	194 108	0.3
Total	246 725	2.7	245 882	– 0.3

*Amended figures
**Since THQ was reorganised and RHQ/THQ boundaries changed, a comparison would be misleading.



1980/81 **1981/82**

With a profit for the 1981/82 financial year of £458 million, British Telecom will have earned a 6.5 per cent return on capital – 1.5 per cent better than the Government's financial target. Its profit on a turnover of £5708 million is just over 8p in the pound and with improved efficiency, saw its business grow by 5.6 per cent compared with the preceding financial year.

Parties of schoolchildren from all over the country are regular visitors to the Showcase.

Telecom on show

It is no coincidence that British Telecom's new Telecom Technology Showcase, situated in the Baynard House annexe in London, officially opened in 1982 – Information Technology Year. The Showcase is the only place in the capital where the public can trace 200 years of telecommunications progress from the earliest naval telegraph systems to today's electronic office.

The first recognised museum devoted to telecommunications, opened in 1961 at Fleet building in the City. Sponsored by the then London Telecommunications Region (LTR), the museum operated for ten years under the curatorship of Major J K Zieleznik MC. In 1971, it was closed for financial reasons.

Realising the enormous value of the material already amassed, and the volumes of historical documents and other ephemera lying in discarded office cabinets and files throughout the country, LTR, in 1978, appointed a young university graduate, Neil Johannessen, to be the curator of the new Telecommunications Museum. Since then, the name has changed and the concept of the Museum has been expanded to provide a comprehensive picture of telecommunications developments, products and services.

Under its new name, it traces progress from the simple telegraph and semaphore of the early nineteenth century through to today's sophisticated digital transmission and satellite links, and on to glimpses of things to come.

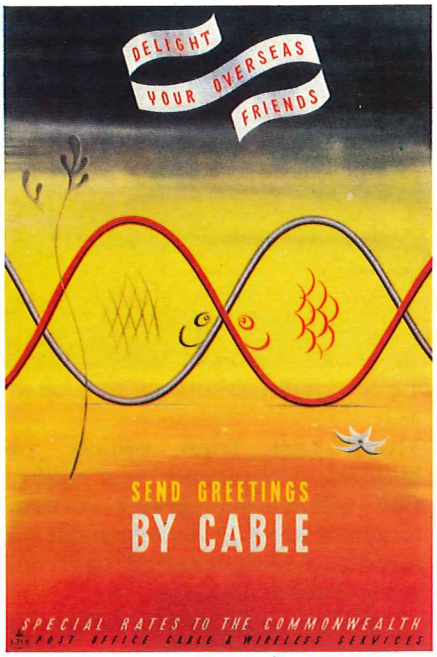
With telecommunications technology continuing to develop apace, few would dispute the value of introducing the subject into the classroom curriculum.

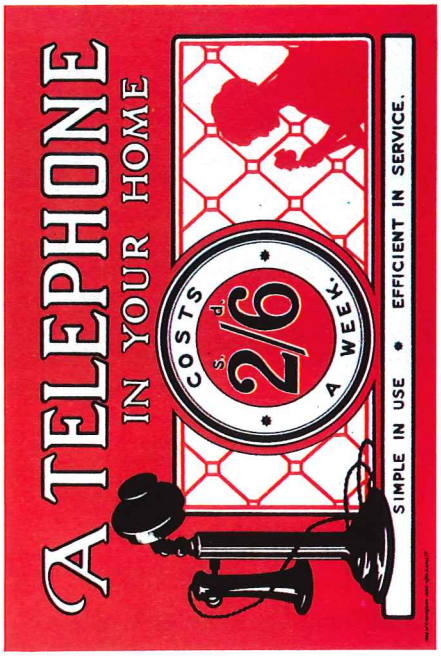
And particularly fortunate in this respect are schools and colleges in and around Oxford where for many years the British Telecom museum has opened its doors to a succession of eager pupils all of whom will almost certainly be customers in the future.

The museum, founded more than 20 years ago by its curator, former engineer Reg Earl, has been widely acclaimed and many students at primary, secondary and university level have made use of its facilities for projects and theses.

But encouraging the educational side is only part of Reg Earl's work. He is also solely responsible for collecting, cataloguing and preparing equipment for display at what has become a city centre show piece.

Oxford museum curator Reg Earl plays host to a party of students.





A selection of posters which can be bought at Showcase.

Designed by museum specialists Robin Wade Design Associates, Showcase has been mounted on two floors. At entrance level, there is a general story of telecommunications, ranging from sections on semaphore telegraphs and electric telegraphs through to subscriber trunk dialling, international direct dialling, satellites and Prestel. There are also displays on System X, optical fibres, and working slow-scan television and digital facsimile.

Specific topics are dealt with on a lower floor in greater detail for visitors who are looking for more technical information. Nearby is a study centre housing an historical selection of books, manuals and journals covering all aspects of telecommunications over the years.

Baynard House is an apt choice to house Showcase. Located near Blackfriars Bridge in the City of London, and next door to the Mermaid Theatre, Showcase stands by some of the most up-to-date telecommunications equipment in use in the world today – including the UK's first long-distance, inter-city optical fibre link between London and Birmingham.

In its first three months, Showcase entertained more than 3,000 visitors. A comprehensive brochure can be bought on entry, and guides are available to conduct parties around the display areas. On sale is a wide range of postcards and there is a particularly fascinating selection of facsimile publicity posters from pre-war to Buzby.

But Showcase is not just about the past, or even the future. Significant display space has been provided for up-to-the-minute products and services currently on sale or for rent. And if British Telecom through Showcase can encourage customers to buy the latest telephone or private exchange while at the same time entertaining and informing them, then the enterprise can certainly be regarded as a success. Ⓣ

Telecom Technology Showcase is open every Monday to Thursday between 10.00am and 4.30pm and is located at Baynard House, 135 Queen Victoria Street, London EC4V 4AT. For further information telephone 01-236 0809.

Setting new standards

The headquarters of BSI's quality assurance division at Hemel Hempstead.

A new laboratory specialising in testing telecommunications equipment has been opened by the British Standards Institution. This article by **Alan Attryde** of BSI outlines the close co-operation between the Institution and British Telecom from the earliest planning stages.

Less than one hour's drive from Central London, and close to the M1 at Hemel Hempstead in Hertfordshire, lies the impressive British Standard Institution's (BSI) Test House. One of the largest of its kind in Europe, it has 14 separate laboratories providing a wide range of testing facilities each specialising in a different group of products. These vary from vehicle and building components to a calibration verification service covering temperature and density measurement and electrical and electronic equipment of all kinds.

Although originally set up with the aim of providing test facilities to support BSI's certification schemes, this activity now takes up less than 30 per cent of total capacity. This means that the remaining facilities are generally free to serve both private and public sectors of Industry as well as the needs of many of the regulatory bodies. But of particular interest to British Telecom this year was the opening in July of a new extension consisting of a laboratory specialising in testing telecommunications equipment. The decision to establish this facility was taken in December last year following the announcement of the proposed liberalisation of the telecommunications network.

In the following months, there was particularly close co-operation between British Telecom staff and BSI. Senior staff from both sides attended meetings of BSI technical committees which were working to tight schedules to develop the required British Standards which are to be the basis of the new BABT (British Approvals Board for Telecommunications) approvals.

Particularly helpful was the co-operation from the British Telecom Research Laboratories, Martlesham in supplying some of the purpose-built test equipment. BSI Test House staff were also given specialist training at the London-based British Telecom test laboratories. In return, British Telecom staff from the Birmingham Quality Assurance Laboratories were trained at the BSI Test House on procedures for safety testing a wide range of electrical equipment.

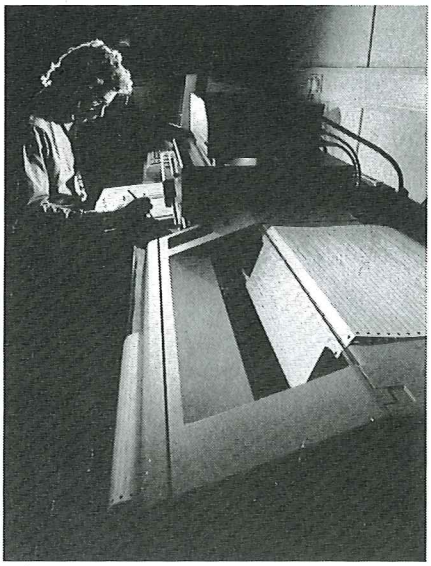
The new laboratory is based on similar ones within British Telecom, and is designed to test the performance and safety requirements of a wide range of telecommunications equipment. A high priority has been the testing of telephone instruments. Among a wide range of equipment used for this purpose has been a computer-aided test facility (CAT) for transmission and acoustic testing. There are three categories of test – safety, compatibility and signalling, and transmission and acoustics.

Safety is important for both the user and

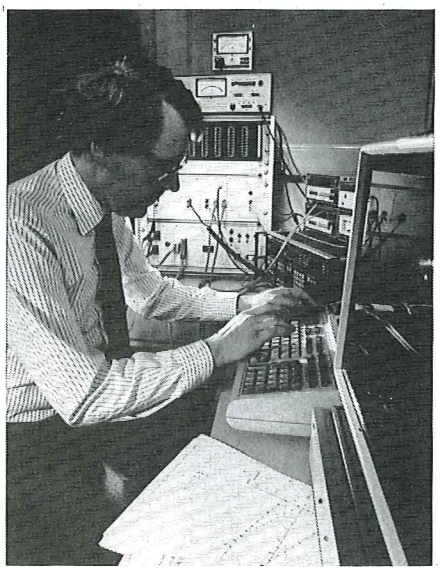
for the public telephone network. For many years, BSI has carried out tests to BS 415 *(Safety requirements for mains-operated electronic apparatus for household and general similar use).* Although compliance with BS 415 ensures safety of the user from the mains supply, a new specification, BS 6301 *(Specification for safety requirements for apparatus for connection to British Telecommunications networks)* was needed to ensure the safety of staff working on the British Telecom network and to protect users from hazards which may arise from connecting apparatus to the network. Some of the safety tests in the laboratory have been applied to power level transmissions, ringing characteristics, provision of protection barriers and isolation devices.

The performance of a telecommunications device must be compatible with the network to ensure efficient operation while at the same time fulfilling its design specification.

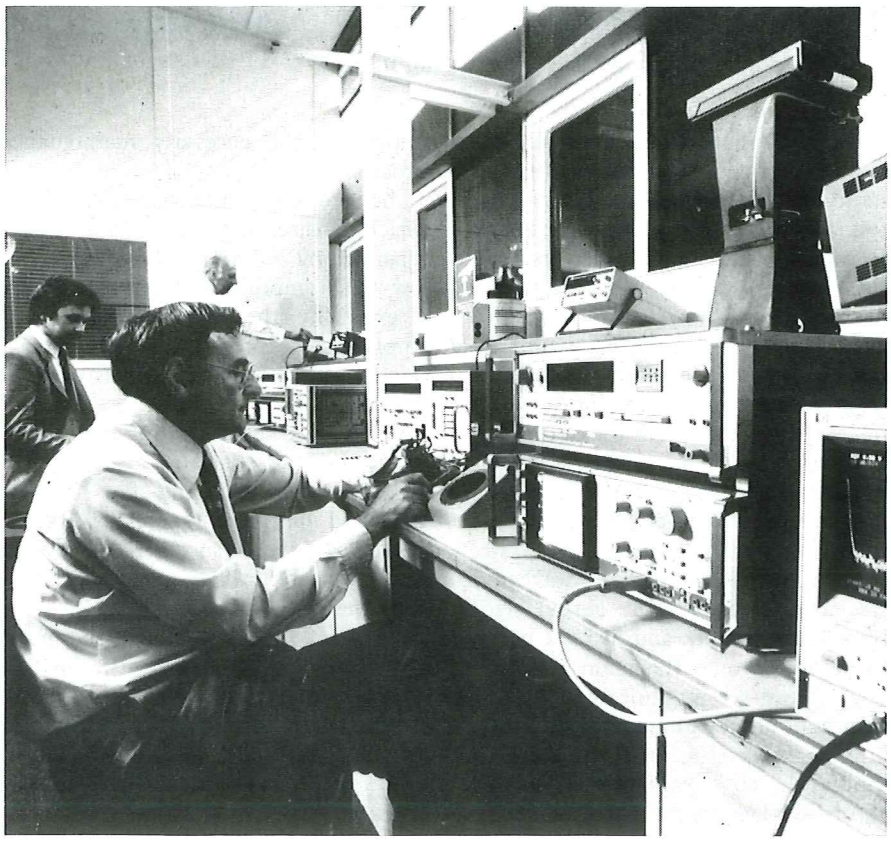
An engineer carries out laboratory transmission tests.



Here new technology is used in computer-aided testing.



Telephone dial testing is just one of the many activities carried out at BSI's new £250,000 laboratory complex.



Some electrical aspects are covered by the tests for network safety, but work is also carried out on signalling performance. This could include for example, the mark/space ratio, interdigit pause, impulsing speed and pulse distortion of loop disconnect signalling and for the frequencies and power levels of multi-frequency signalling. Such requirements are covered by BS 6305 *(Specification for general requirements for apparatus for connection to the British Telecommunications public switched telephone network)* and BS 6317 *(Specification for simple extension telephones for connection to the British Telecommunications public switched telephone network).*

Transmission and acoustic properties of telecommunications equipment must produce an intelligible signal in both send and receive modes. Tests fall into three main categories. The purpose-built CAT facility is used to test speech performance, and consists of an artificial line, mouth and ear, an anechoic chamber and a graphics plotter. It is designed to test three aspects of speech performance by measuring send and receive characteristics, establishing that cross-talk in the network cannot be amplified sufficiently to be heard and minimising the risk of acoustic shock. There are also tests for distortion, clipping, sidetone, noise and instability.

The second category is electrical testing, which includes connection wires, ringing detection and parallel operations with other devices. There is also an acoustic chamber to enable bell and tone caller performance to be evaluated. In the case of carbon microphones, a precise conditioning procedures is followed during measurement tests. Both speech and electrical testing is carried out in accordance with BS 6305 and BS 6317.

The final test category is based on physical parameters and includes checking the layout of the dial or multifrequency keypad and the plug to the new British Standard BS 6312 *(Specification for plugs for use with British Telecommunications line jack units).*

Although early laboratory tests have centred around telephones, BSI expects to enlarge the range of products handled as further British Standard specifications are published. The co-operation between BSI and British Telecom has underlined the good working relationship that has developed between the two organisations and with the challenge of competition already evident, is sure to be a feature of the future.

New role for Goonhilly terminal

R C Mason

The Goonhilly IV terminal showing the beam waveguide.

The rapid growth of international telephone traffic over the last five years has resulted in congestion of the existing 4/6 GHz satellite communication bands and has led to the use of higher frequencies for satellite communication. The first British Telecom antenna to operate commercially in the 11/14 GHz frequency bands is being provided at Goonhilly earth station in Cornwall where the terminal, known as Goonhilly IV, uses an existing 19m antenna whose structure has been modified and where new radio equipment has been provided. The terminal will be in service by the end of this year and will play an important part in the future development of the International Telecommunications Satellite Organisation (Intelsat), in the newly utilised portion of the radio frequency spectrum.

The 19m antenna and small base building was constructed in 1978 as a test station for use with the European orbital test satellite (OTS) – a forerunner of the European communications satellite (ECS). The test station was withdrawn in June 1980 and an extension building constructed to house the large volume of radio equipment required for operation with the latest Intelsat satellites.

The antenna was built on a reinforced concrete ring beam with supporting pillars sunk deep into bedrock. A reflector assembly was formed from aluminium petals mounted on a steel backing structure. A beam waveguide was used to convey the output signal from the feed horn and focus it via the sub-reflector onto the main dish. Use of a beam waveguide enables the communication equipment to be located at ground level in the antenna base building so easing installation, equipment layouts and cabling, as well as improving the necessary maintenance procedures.

The incoming signal from the satellite, which consists of two 250 MHz bands separated by 250 MHz, is amplified by a low-noise amplifier (LNA) after being received by the 19m antenna. Two amplifiers are provided, a main and a standby, and installed in the existing base building.

As far as possible, proprietary radio equipment was installed in the new building thus reducing development work and improving timescales. Certain non-standard items such as the 11/4 GHz downconverter which frequency translates the incoming satellite signal from the 11 GHz to the 4 GHz frequency band have been developed because of the high frequencies being used. Transmission at 4 GHz means that the associated receivers, common to other terminals, can be located centrally easing operational and maintenance functions.

The system is arranged so that if either an LNA or its associated down-converter becomes faulty, then the whole configuration will automatically switch to the fully-equipped standby chain. The output signal from each 11/4 GHz down-converter is transmitted across site via elliptical low-loss waveguide. A spare waveguide is provided and waveguide switches select two signal paths from the three available.

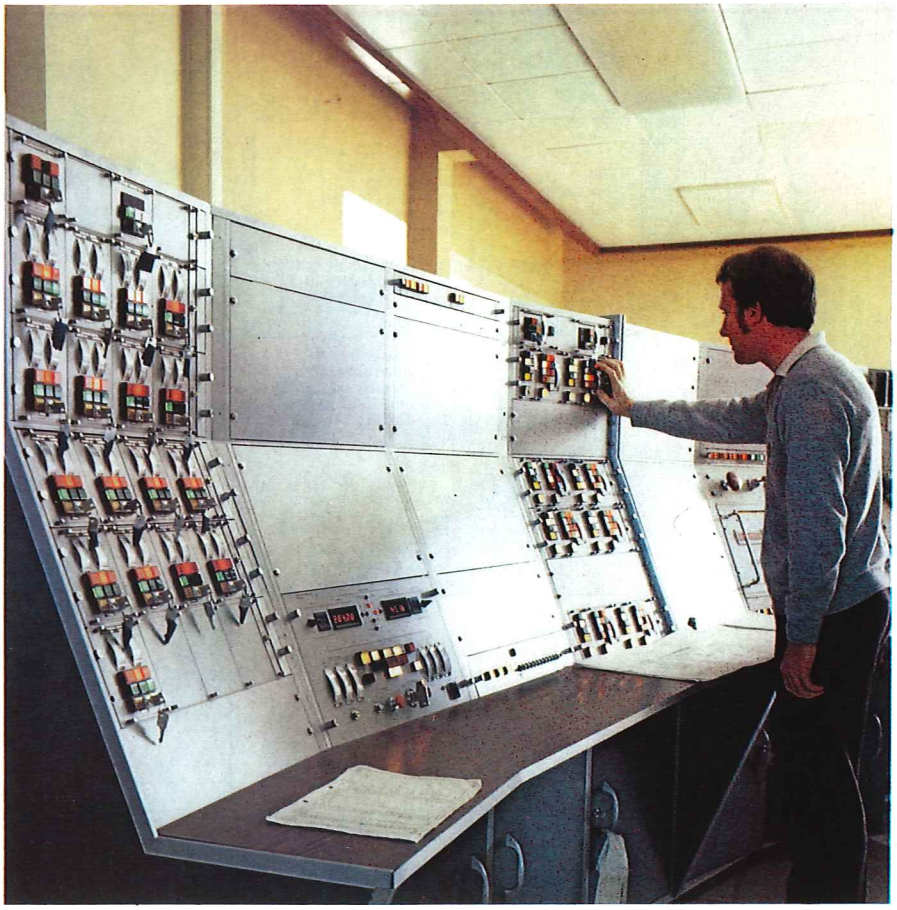
The two signal paths in the main building are fed to broadband super high frequency (SHF) splitters which in turn feed 34 telephony receivers. These receivers are configured in a main and standby arrangement resulting in 17 traffic paths, which are routed via baseband equipment to the multiplex equipment for re-transmission via terrestrial links.

The corresponding baseband signal for transmission via the satellite is modulated onto a 70 MHz carrier. The baseband and modulation equipment is located in the central building and the output signal is transmitted across site by coaxial cable. Equalisation and filtering are performed at the aerial site at 70 MHz before frequency upconversion to the 14 and 14.5 GHz band. This frequency translation is performed by a number of upconverters, of which two are reserved for 'contingency' and are used solely for support services in the event of submarine cable failure.

The initial provision is for eight tunable 14 GHz 2kW Klystron high-power amplifiers (HPA) each incorporating a 14–14.5 GHz travelling wave tube driver amplifier. The HPA is a modified and redesigned version of the successful 6 GHz and 14 GHz amplifiers used at Madley earth station near Hereford and the OTS test station respectively.

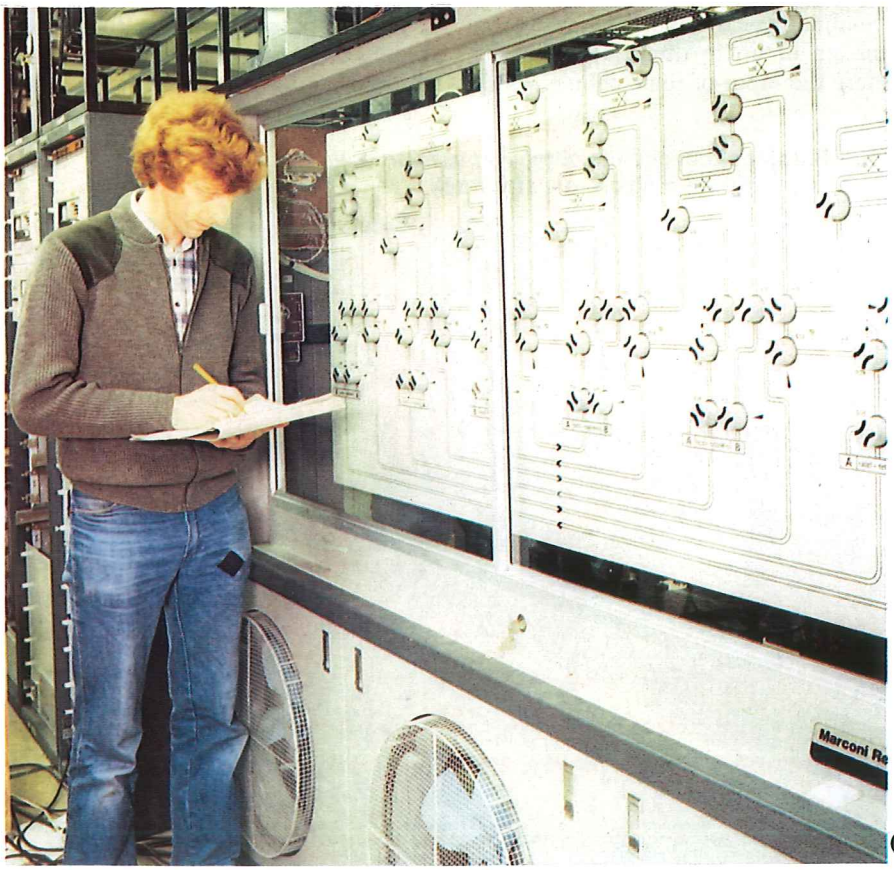
The amplifiers are configured in two groups, each group having two main, one standby and one contingency HPA. Each main path amplifier is directly connected to a transmit chain which comprises baseband, modulator, cross-site and upconverter equipment. The standby and the contingency transmit chains are connected to the standby and contingency HPAs via a waveguide switch network. These input switches act with the waveguide switches at the output of the HPAs to route the correct standby transmit chain to the standby HPA. This equipment thus completely replaces the main path should a failure of any part of the main telephony path occur. The waveguide switching is so arranged that if the standby HPA should fail or be under maintenance then the contingency HPA can be substituted.

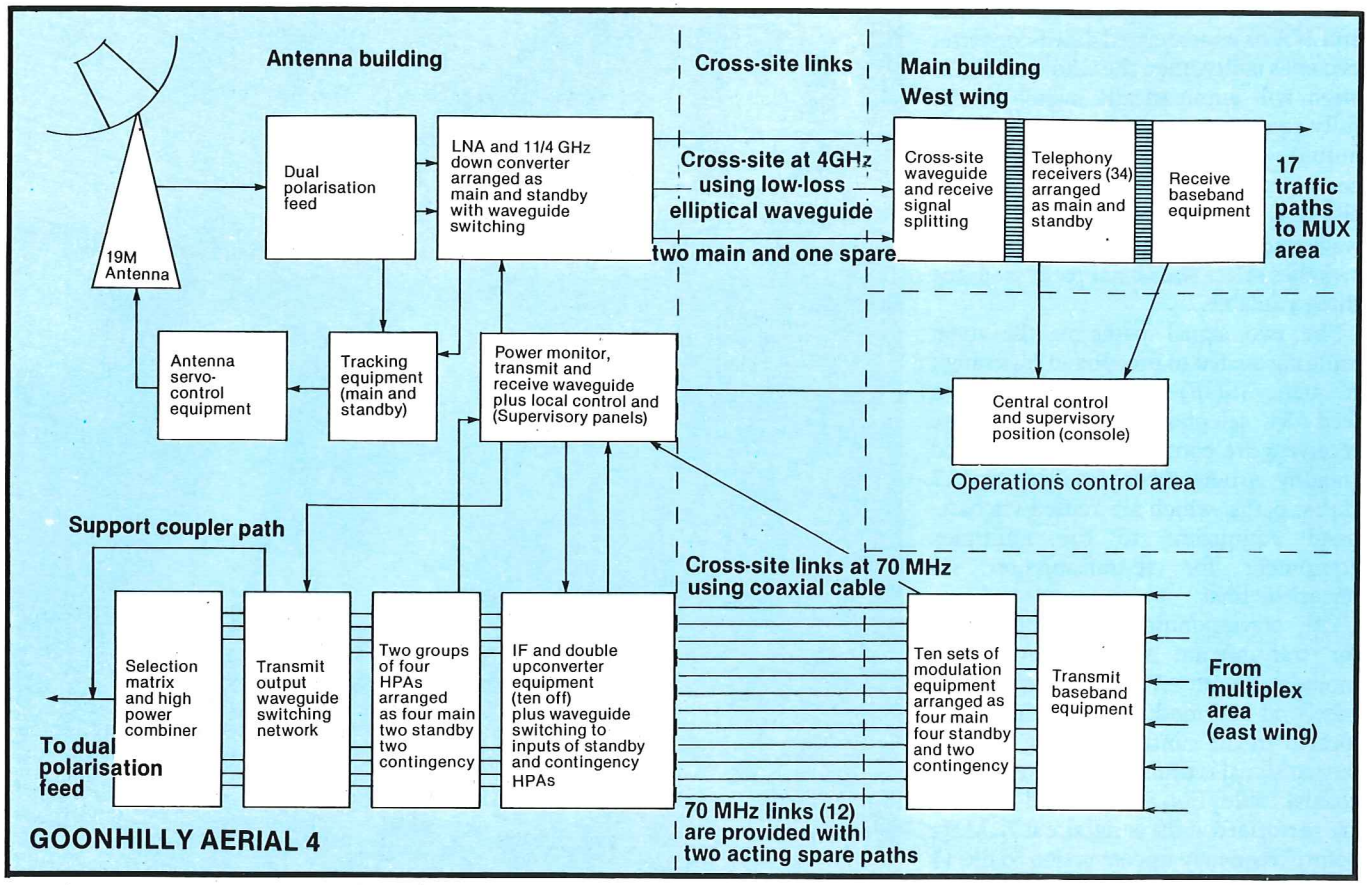
The output from the HPA waveguide



Technical officer Peter Collins familiarises himself with the transmitter control on the Goonhilly IV console in the operations control area.

Another technical officer, Martin Webster, checks the routing through the selection matrix housed in the aerial building.





switches is routed by waveguide to the input of the waveguide selection matrix and combiner. The purpose of the matrix is to give a flexibility point between the output of the HPAs and the input to a combiner which is responsive to certain frequencies. Additionally, the matrix has a combining section which allows a combination of up to three HPA outputs before the input of the combiner. This effectively increases the number of transmit carriers which can be radiated by the station.

The matrix is formed by channels machined out of solid aluminium billets. When assembled, the channels form waveguides and machined slots between parallel channels form the combining sections. Selection of routes and polarisation switching is achieved by manual operation of waveguide switches, which have been formed by locating the switch rotors into holes bored into the solid block. During a reconfiguration of a transmit carrier, the carrier may be routed round the matrix-combiner network by the waveguide switch network and re-inserted via a broadband coupler after the combiner. This frees the matrix input port and associated switches for reconfiguration.

A high-power low-loss combiner is located below the selection matrix. The combiner has six input ports each non-overlapping in frequency and nominally 80 MHz bandwidth. The port bandwidth and position within the frequency spectrum corresponds to the nominal satellite transponder bandwidth and position. The output from the combiner is routed via waveguide to the input of the dual polarisation antenna feed.

There is little doubt that much of the future expansion of satellite communications will take place in the higher frequency bands and further 11/14 GHz terminals will, in due course, be provided at the Madley earth station.

Peter Barnicoat checks the computer used to drive the aerial during its programming on to a star track.

Mr R. C. Mason is an executive engineer in British Telecom International's earth station planning and provision division.

British Telecom Journal, Autumn 1982

Calling the North Sea

A revolutionary new era in offshore communications became reality in September when British Telecom and Amoco successfully started small-dish satellite communications to an oil platform in the North Sea.

Trial transmissions carrying speech and data have been set up between British Telecom's North Sea radio station near Fraserburgh, Scotland, and Amoco's Montrose Alpha oil production platform 120 miles east of Aberdeen. The three-month long experiment is designed to demonstrate the applications of small-dish satellite communications to offshore oil and gas fields.

During the trials, Amoco will have six telephone lines linked to the public telephone network and a mixed speech and message circuit with a special connection to provide access to the UK telex network. The telephone links are for business use only and during the trial will augment existing circuits. British Telecom International will also be experimenting with slow-scan television, facsimile, electronic mail, teleconferencing and telex equipment.

Test transmissions will record the effect of weather on system performance. This is the latest in a series of SatStream trials – a satellite-based X-Stream digital service which is to be offered to UK businesses in 1984 to provide specialist private communications within the UK and Europe.

British Telecom Journal, Autumn 1982

Final adjustments are made to the dish aerial installed on the Montrose-Alpha oil platform.

GOING FOR GOLD

Customers are already making good use of Telecom Gold services. Here, Elizabeth Knott of Midland Bank International's business systems department runs through the Mailbox service provided by Dialcom.

March this year saw a new era for telecommunications. It heralded the launch of British Telecom's electronic mail service, Dialcom, and Telecom Gold, a new company set up to spearhead the communications drive into office automation. The unique combination of a British Telecom service provided through an independent company has captured the interest and imagination of both potential customers and observers alike.•

Progress has been remarkable by any standards – already the company has more than 70 customers with nearly 1300 mailboxes assigned. Indeed, the three key ingredients have been high-quality service, commercial flexibility and hard work. Because of this, both Dialcom and Telecom Gold have been able to keep one step ahead in this fast moving new automated office service market.

But the challenge of managing these electronic mail and automated office services has provided Telecom Gold with the foundation for expansion. Already, a database management facility is available and trials to interconnect facilities to telex, telemessage and radiopaging have started. And work on teletex and message transfer standards has also been scheduled.

The next two years should see a continuing improvement in the international electronic mail service as well as a broadening of interconnect and gateway services. Diversification into customers' premises with hardware, systems and networks connected through the central bureau mail gateway service is also being considered.

These future plans mean the provision of a comprehensive range of services designed to meet the needs of business and private users alike. The tremendous support and backing given to Telecom Gold by British Telecom to market and develop their service is unquestionably a powerful market ally. ⓣ

British Telecom Journal, Autumn 1982

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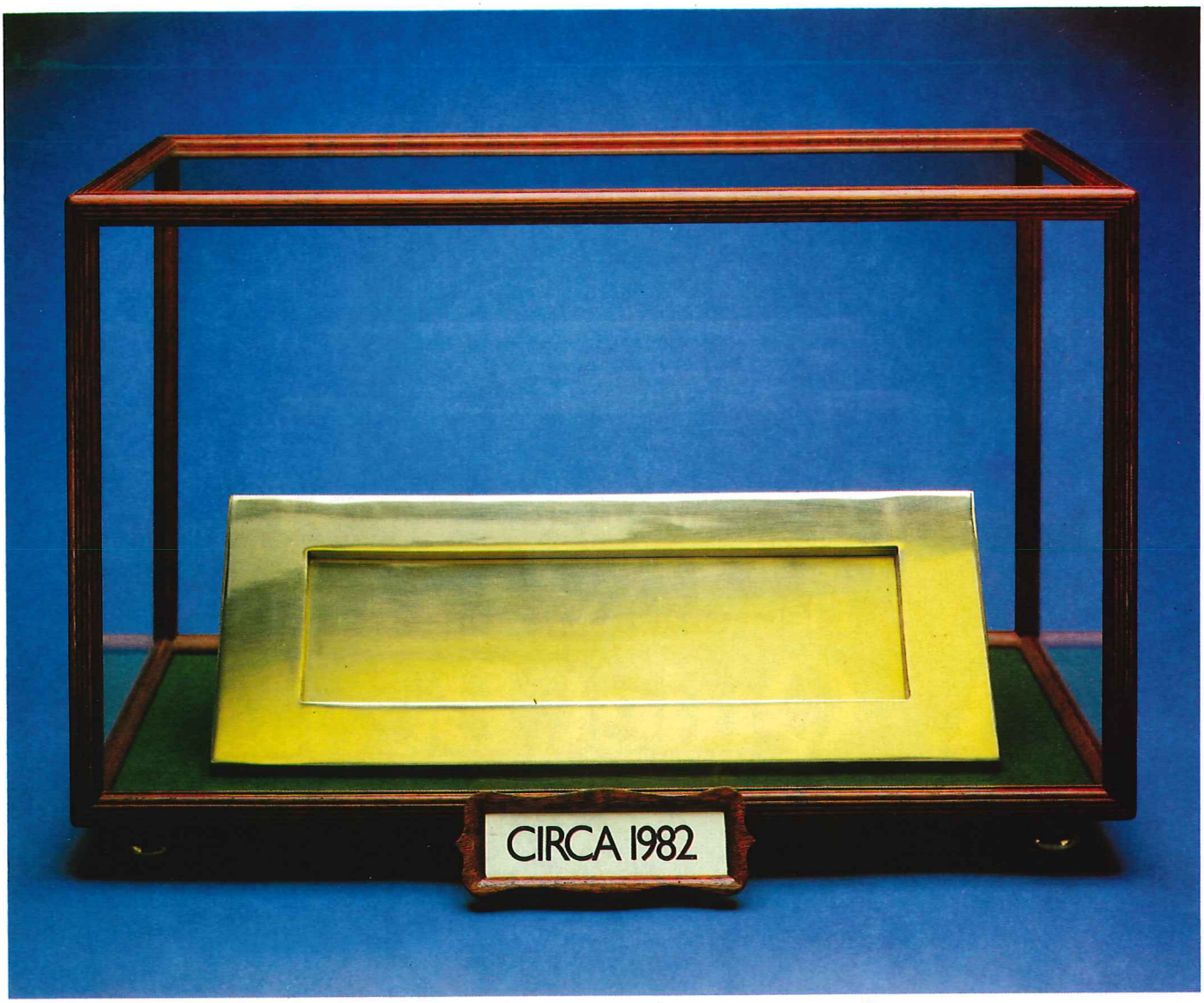

On March 22nd, British Telecom revolutionised office communication

Electronic mail is here — and with it comes a revolution in office communication.

The new service uses your existing terminals to send your company's letters, memos, reports and messages. Delivery to your colleagues' "electronic mailboxes" is virtually instantaneous — whether it's a single letter or a circular memo to 500 branch offices.

The service will also maintain distribution lists, design and process forms, manage your filing, maintain your diary, work with word processors and offer you a company "noticeboard". Large databases can be created and managed, and you can even "chat" through the service.

This is a new mind-opening development from British Telecom. It's called Dialcom, and is brought to you by Telecom Gold Limited, an independent company backed by British Telecom to market this service.

Start the revolution in *your* company, contact us for the details.

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MISCELLANY

Increases deferred

In the light of improved internal results and the prospect of a continuing drop in inflation. British Telecom has deferred proposed price increases due to take effect in November.

The tariff proposals which British Telecom put to POUNC for an increase of some six per cent less than the current rate of inflation, and a year after the previous increase, were framed primarily to put British Telecom in a position to meet its forecast financial requirement in 1983/84.

Since the proposals were framed earlier this year, however, there has been a continuing improvement in the operating environment. The prospect of rapidly falling inflation, rapidly falling interest rates and containment of internal costs have all contributed to a more favourable outlook.

Order book open

British Telecom has begun taking orders for a new digital communications service for businesses which will come into operation early next year. The new service is KiloStream – one of the X-Stream family of digital communication services which were launched at the beginning of the year.

It is a private circuit service, providing direct links between two or more points leased to customers for their exclusive use. It provides for operation at data rates up to 64 kbit/s on a single telephone speech channel without the use of modems – devices for converting digital data into a form suitable for transmission on the telephone network.

More on datel

British Telecom's international datel services are now available to Fiji and Iceland. This brings the number of countries that can be dialled over the datel network to 25.

Most countries using the service, including both Fiji and Iceland, can be dialled direct by customers in the United Kingdom.

Brighton symposium

The second international network planning symposium organised by the IEE, in association with the IERE, will be held at the University of Sussex, Brighton from 21 to 25 March next year.

The symposium will be opened by Sir George Jefferson, Chairman of British Telecom, and is expected to draw up to 500 delegates, many from abroad. It is the second in a series of international symposia which is recognised as the world forum for the interchange of ideas and information on planning of telecommunications networks.

A good response has meant that 74 high-quality papers from 18 countries have been selected giving a balanced coverage of the latest developments.

More information and copies of the programme may be obtained from the Institution of Electrical Engineers, Conference Department, Savoy Place, London WC2R 0BC.

From the Queen

Royal telemessages have replaced the Queen's traditional greetings on 100th birthdays and diamond weddings following withdrawal from service of inland telegrams. They consist of a special card bearing the Queen's coat of arms in a yellow telemessage envelope marked with a Scottish or English crown and the words 'From the Queen'.

The Royal messages come in by private circuit from the Court Postmaster at Buckingham Palace to a new telemessage centre in Electra House on London's Embankment.

Telemessages were introduced by British Telecom a year ago as a replacement for the overnight telegram and eventually the ordinary inland telegram.

Withdrawal of inland telegrams was announced earlier this year. They lost more than £21 million in 1981 and declined from a peak of 63 million sent in 1945 to two million sent last year.

Cards not coins

The cashless society came a little closer in September with a multi-million pound order by British Telecom for 8,600 Card phones – public phones which use a plastic card instead of coins.

The distinctive phones, with a green and white 'Cardphone' sign, first appeared on trial in London, Birmingham, Manchester and Glasgow last year.

The cards are imprinted by a special holographic process with fivepence call units. They are obtainable from post offices and retail outlets near the phones. There are two values of card – 40 units (£2) and 200 units (£10).

The trial showed that Cardphones were highly reliable and that they took nearly twice as much revenue as the phones they replaced. Research has shown that one of the attractions for users is the convenience of using a card instead of having to search for coins.

Informal meetings

British Telecom London are again holding a series of monthly informal meetings during the winter months.

Future meetings include topics such as Personnel (10 November), Crime (9 December), System X (18 January) and Marketing (16 February). They are open to British Telecom staff only and are held in Camelford House, Albert Embankment, beginning at 5.00 pm.

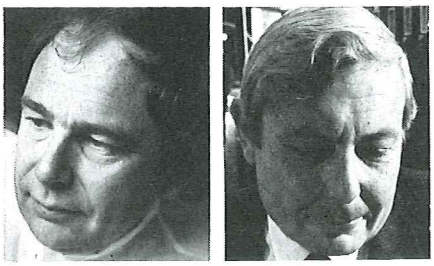
Flying the Ensign

The market trial of Ensign – one of British Telecom's latest call connect systems – began in September when the first of 50 installations was brought into use in the Bedford Telephone Area.

Occupying less than two square feet of wall space, the virtually silent equipment does not require bulky cable to extension telephones. The basic capacity of two exchange lines and four extensions can grow as required up to 12 circuits.

Among the standard facilities provided are abandoned call ringback; diversion of incoming calls; hold and enquiry; repeat last number; repertory calling; three-party conference and transfer-on-ringing/busy.

Following the product trial Ensign was being launched in eastern England, London and the south-east during the autumn and progressively throughout the UK by March next year.

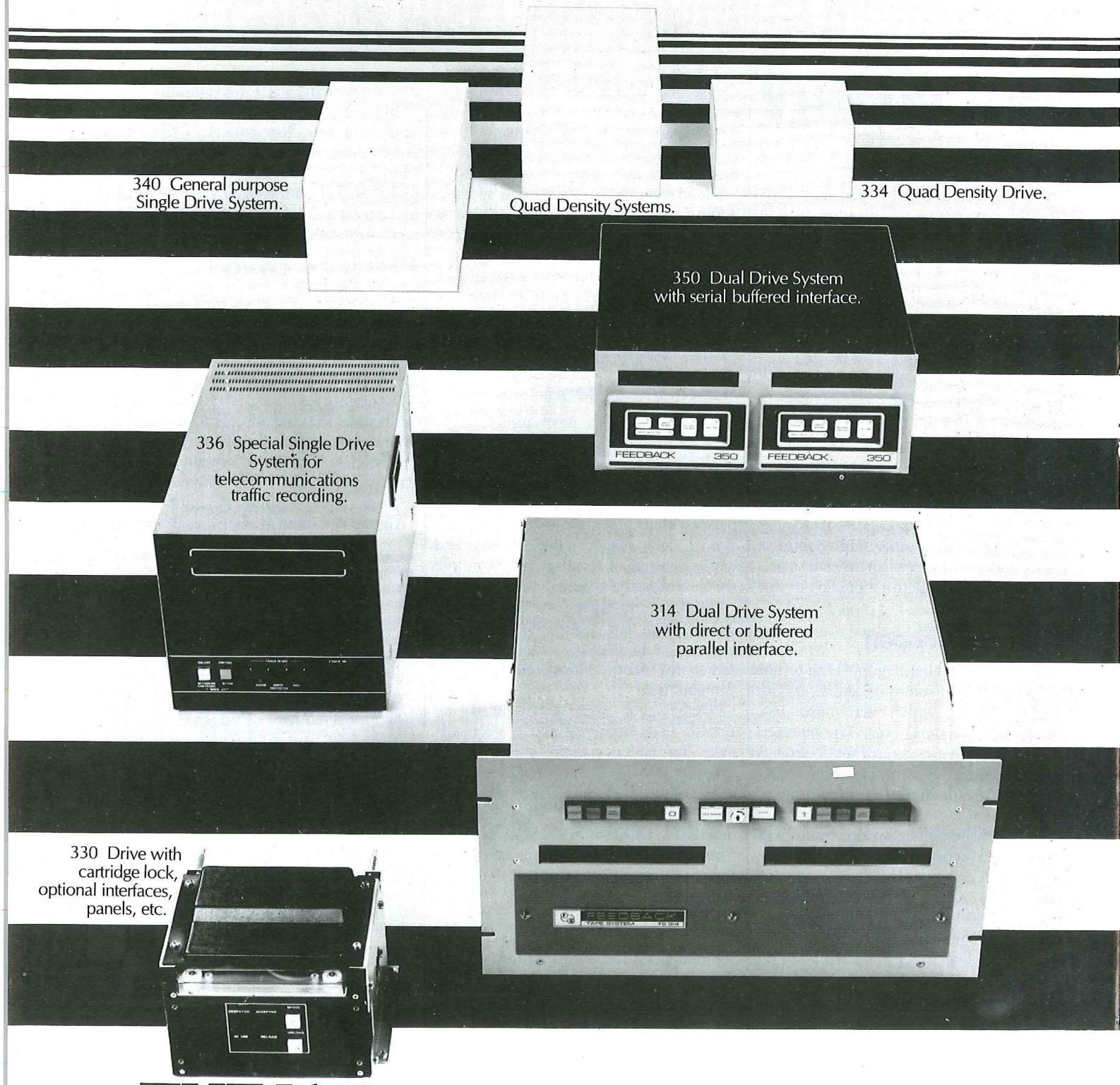


Winners of this year's Martlesham Medal are Dr George Newns and Dr Keith Beales who were key numbers of a research team which more than ten years ago, helped to give Britain a world lead in optical communications. They developed the 'double crucible' method of making optical fibre from a crude laboratory concept to a highly successful production process.

Ahead of schedule

The largest single telecommunications project of its kind ever handled by British Telecom has been completed several weeks ahead of schedule and in an unusually short time.

More than £1½ million-worth of equipment has been provided by British Telecom for members of the London International Financial Futures Exchange (LIFFE) which opened in the Royal Ex-



THE WAY AHEAD FOR TAPE CARTRIDGE USERS

The Feedback Data 330 Drive has established itself as the standard amongst discriminating users such as the telecommunications industry who demand efficient and reliable operation.

To the widely-used 314 dual-drive, parallel interface systems and the special purpose units such as the 336 traffic recorder we have recently added the 350 system. The micro-processer controlled, dual-drive 350 system with twin serial communications interfaces can be used as a simple data dumping and retrieval device for data logging. Alternatively, via a comprehensive instruction set it can operate as a fully controlled peripheral unit.

Next in line, to be announced shortly, will be the 340 single drive system with a range of optional parallel or serial interfaces followed by the 334 high density drive and high density systems.

Feedback

Feedback Data Limited
Uckfield, E. Sussex TN22 1PT
Tel: Uckfield (0825) 61411. Telex: 95607.

change towards the end of September.

Telecom's City area put together a special team of 25 installation engineers and while construction work went on they worked 25,000 man hours to complete work in about five months that would have normally taken nine.

Contracts

Plessey Telecommunications Ltd – £40 million to supply new microprocessor-controlled payphones.

Installation will begin early next year, after an initial trial in Birmingham. By the mid-1980s, all 77,000 public payphones will have been replaced. The new payphone will accept a variety of different coins.

Standard Telephones and Cables plc – £250,000 for signalling units from the Newport (Gwent)-based Electronics Division. Delivery of the equipment began in August and will be completed early next year.

TMC Limited – £2.7 million for the supply, installation and commissioning of 140Mbit/s digital transmission systems linking London, Birmingham, Manchester and Reading. The contract calls for installation to start in autumn next year with completion by early 1984.

Tests pave the way

Tests paving the way for a revolution in transatlantic communications – face-to-face business conferences – have been started by British Telecom International (BTI) and the American Telephone and Telegraph Company (AT&T).

Engineering tests were initiated over a transatlantic cable link set up between British Telecom's London Confravision studio and AT&T's Picturephone Meeting Service studio in New York. Television pictures are already sent over the Atlantic many times a day, but the link capacity of about 1,000 telephone channels, is too expensive for business videoconferencing.

These new tests use digital techniques, in which a codec (coder/decoder) converts pictures and sound into on-off electrical pulses instead of the traditional wave form of analogue transmission. By sending only the changes in picture content, digital signals can be carried economically using a fraction of the capacity otherwise required.

New director

Dudley Edward Fielding, 48, has been appointed finance director of British Telecom Enterprises, the new competitive arm of the corporation. He joins from GEC where he has had considerable experience over the last 15 years in a decentralised organisation, mainly in that of group finance director's role.

One of the initial objectives of Mr Fielding's new post will be to help form independent operating divisions within British Telecom Enterprises, and to ensure that effective control systems are established to enable those divisions to achieve profitable growth and remain competitive.

Every telephone customer in the United Kingdom can now dial direct abroad – to 121 countries and 440 million phones – 93 per cent of the world's total telephones. This is the most comprehensive direct dialling (IDD) service in the world and was achieved when the last four exchanges – at Ammanford, Holyhead, Machynlleth and Monmouth were given the facility.

Our picture shows this year's Miss Wales, Caroline Williams, celebrating the landmark with a visit to London.

Welsh appointment

Keith Gorton, currently general manager for British Telecom's Liverpool Area, has been appointed Chairman of Wales and the Marches Board. He succeeds Michael Ford who becomes Chief Executive, International Business Services, British Telecom International.

Meetings by phone

A new phone-conferencing system which allows up to ten people to hold a meeting over the phone is now undergoing trials by British Telecom.

Participants join the conference directly from the nearest phone wherever they are, even from a public kiosk. Called Meet Me, the system will be particularly useful for salesmen and other businessmen who travel a great deal.

The conference is set up by booking the date, time and duration through a London centre on 01-628 3130 and giving a list of the people taking part. A London telephone number will then be allocated for the conference.

By ringing that number at the specified time and, after an operator check, they are connected to the conference, which can be arranged for any time between 8am and 6pm Monday to Friday, except public holidays. The new system differs from British Telecom's existing conference service where those taking part are rung by the operator at a predetermined number.

Sponsored award

British Telecom is to sponsor a new Institute of Sales Promotion award for the most imaginative use of the telephone in a sales promotion. The award, which will be presented next March, will be accompanied by a £1,000 credit which can be used to offset telephone bills.

British Telecom customers make a total of 20 billion calls a year, both for business and pleasure, but selling by phone is seen as a potential growth area.

Application forms to enter for the award can be obtained by dialling 100 and asking the operator for Freefone ISP. Ⓣ

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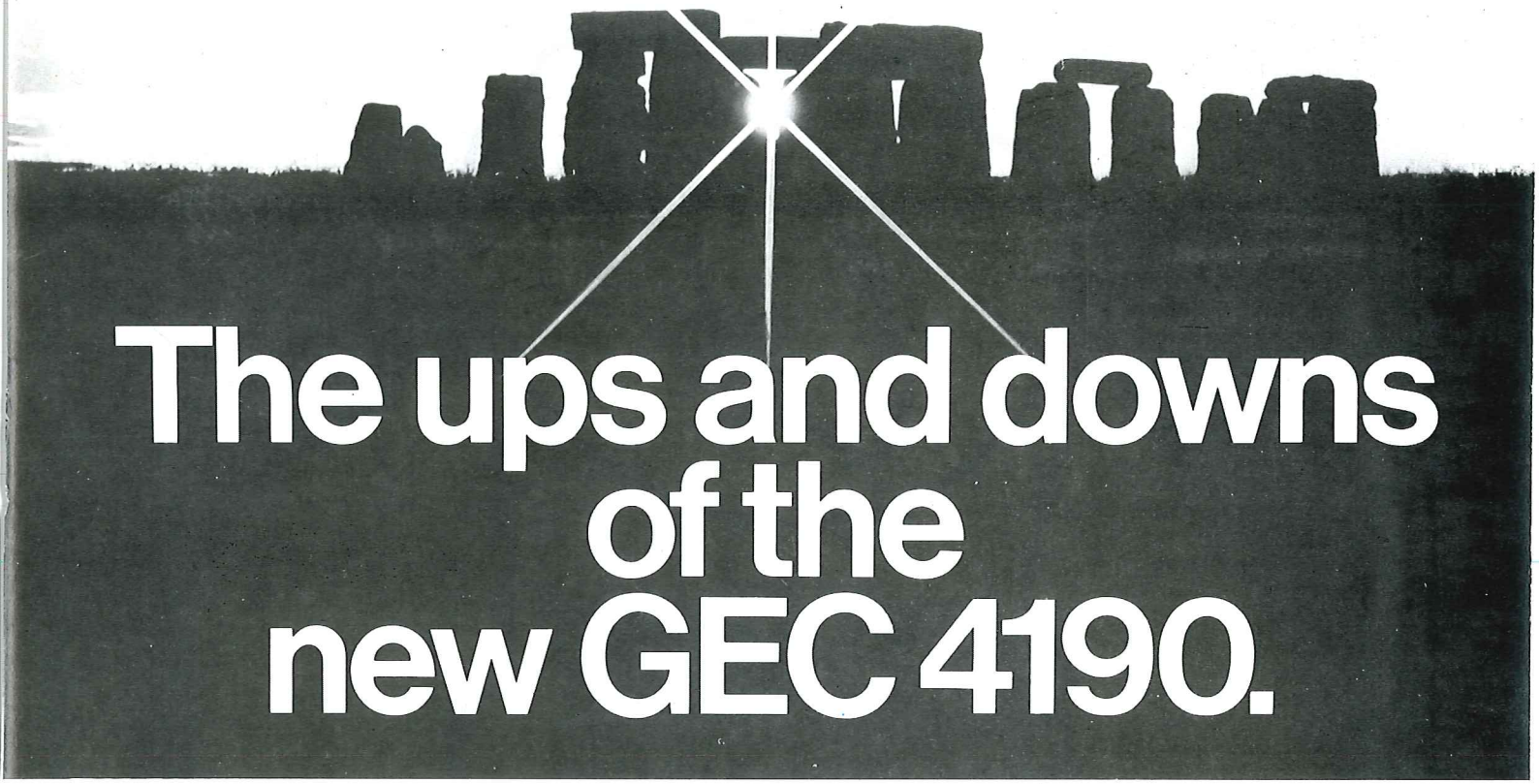

The ups and downs of the new GEC 4190.

Up: reliability.

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Down: price.

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Up: capacity.

Taking advantage of the latest developments in microchip technology, the GEC 4190 uses 64K RAMs contained within the CPU to provide modules of 1 Megabyte of main memory on a single board.

Down: power consumption.

The compactness of the new GEC 4190 has given a significant boost to power conservation. In some cases power consumption has been reduced by an astonishing 70%.

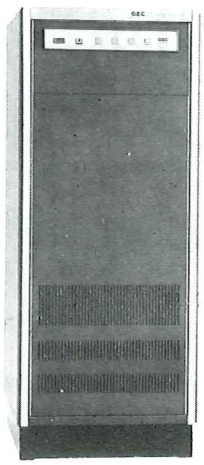
Up: performance.

In its present 32-bit, 64K RAM form, the GEC 4190 turns in an outstanding performance, but this is only a taste of what the future holds. For instance, the basic store boards are designed to cater for 256K RAMs. When these become a commercially-viable proposition it will be relatively simple to build 16M Bytes of main store into the CPU.

The GEC 4190 is fully compatible with all the machines in the GEC 4000 Series and enjoys the facilities afforded by the award-winning 'Nucleus' central executive.

Down: size.

Incorporating the main memory into the CPU has resulted in the machine being reduced to just two cabinets. In a typical 4M Byte system for example, the new GEC 4190 takes up just one third of the space of the GEC 4090.



Up: peripherals.

In addition to the wide range of peripherals available on the GEC 4190, a new option is being offered in the form of an 8 inch Winchester type cartridge disc.

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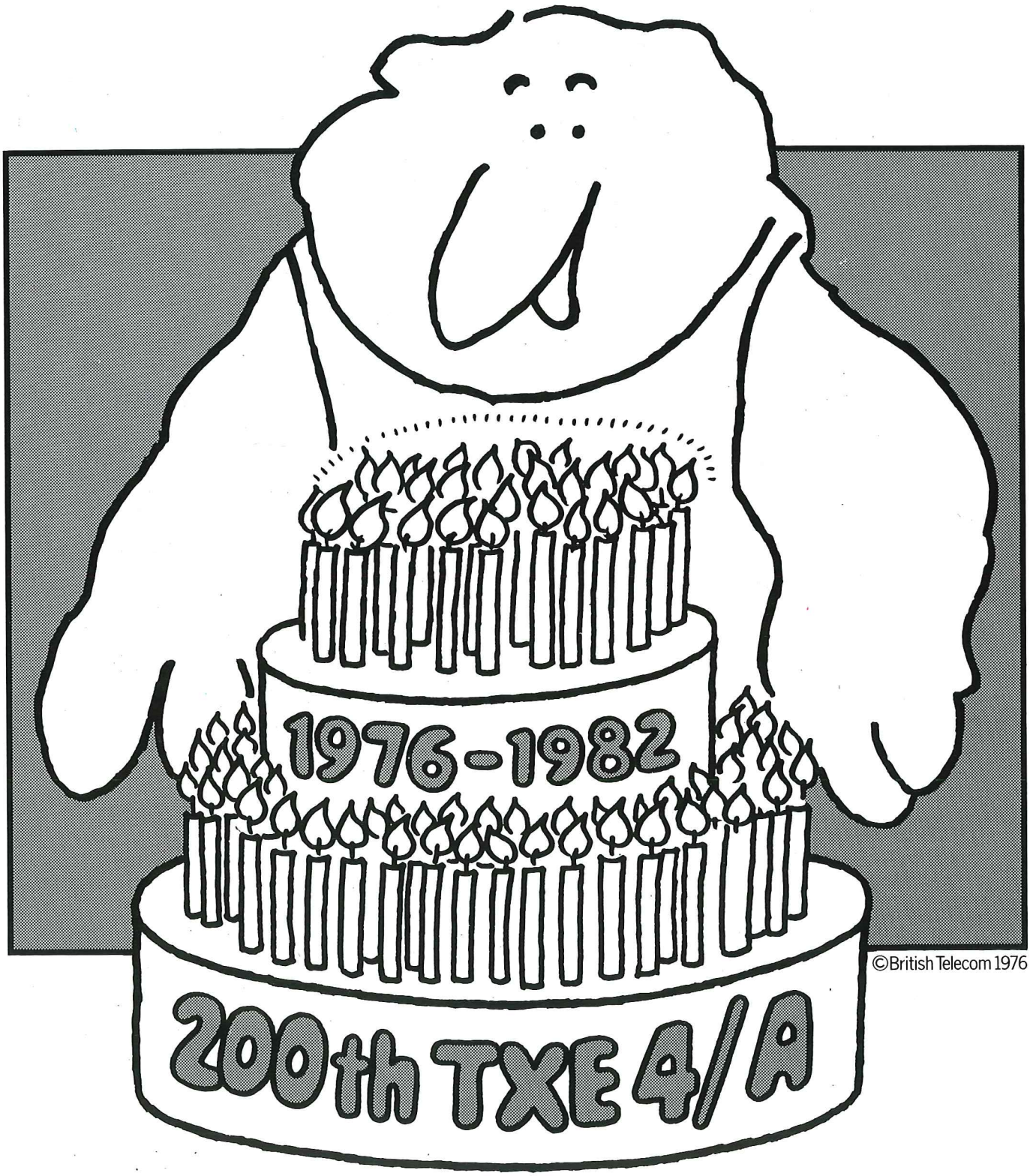

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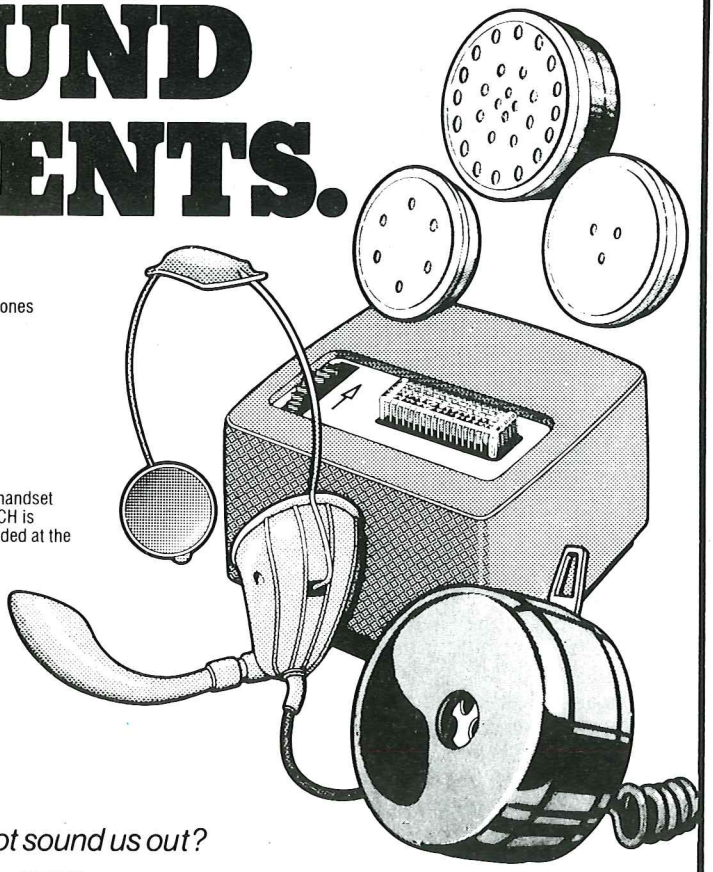

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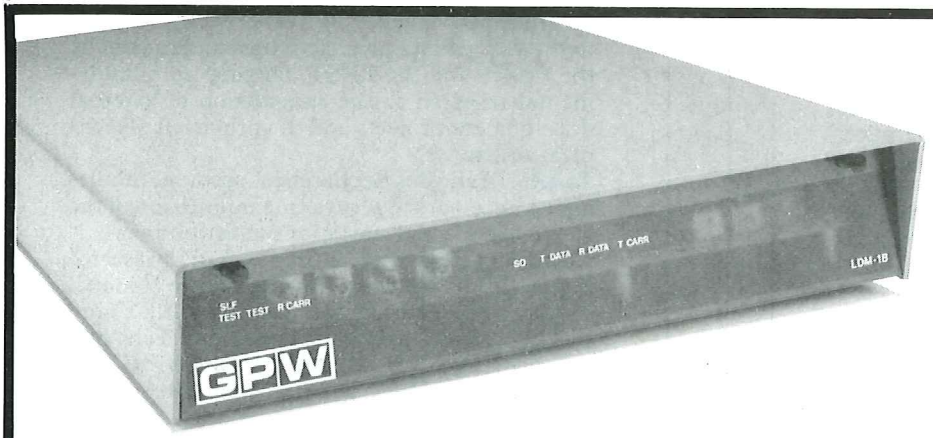

Data Devices

LDM–1B Synchronous transformer coupled modem for use up to 12 miles 9600 bps or 17 miles at 2400 bps with full diagnostics. Speed range 1800 to 19200.

EASI–1B or 2 Asynchronous to synchronous converter allows asynchronous devices (terminals) to be connected to synchronous modems and vice versa. Speeds 150 to 19200.

232/3600 LA or 232/3650 LA Full duplex line adaptor interface unit which converts 1200/2400 IBM bi-polar data to EIA NRZ data and vice versa for use with normal V24/V28 modem etc.

PRS–2 or 3 or 4 Concentrates 2, 4 or 8 data ports or terminals into one port.

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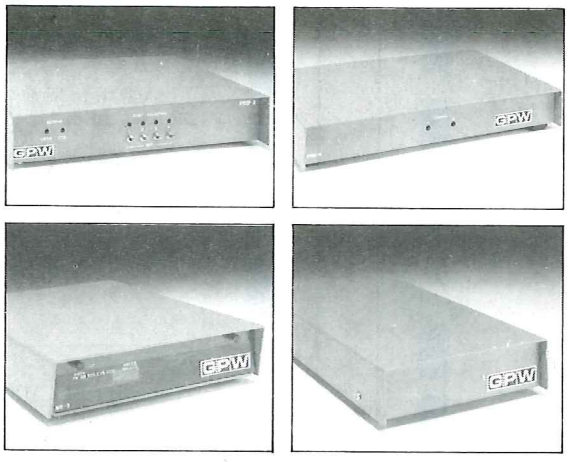

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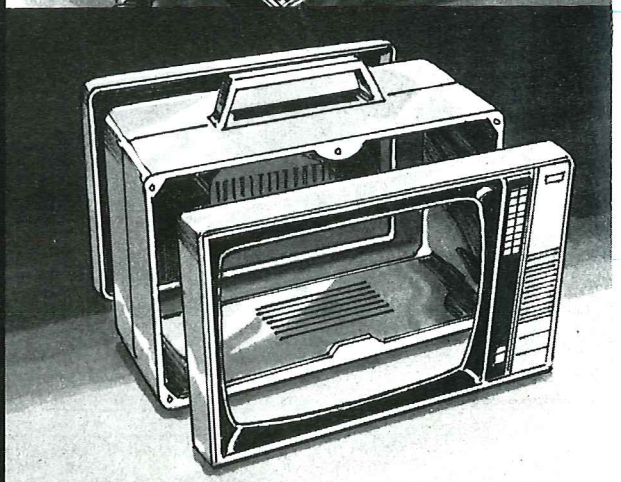

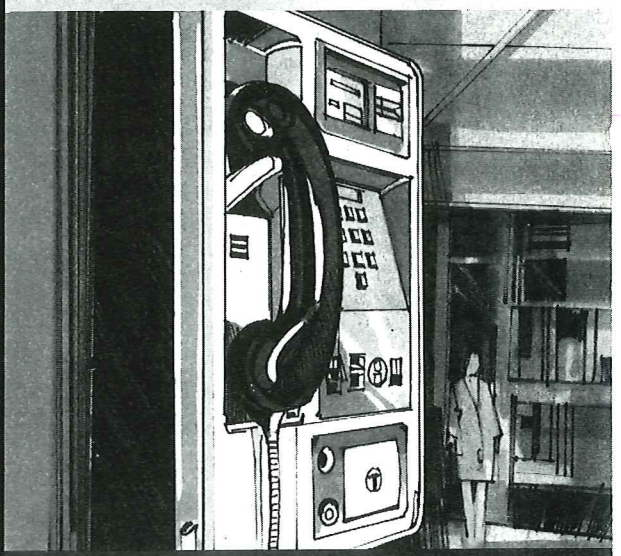

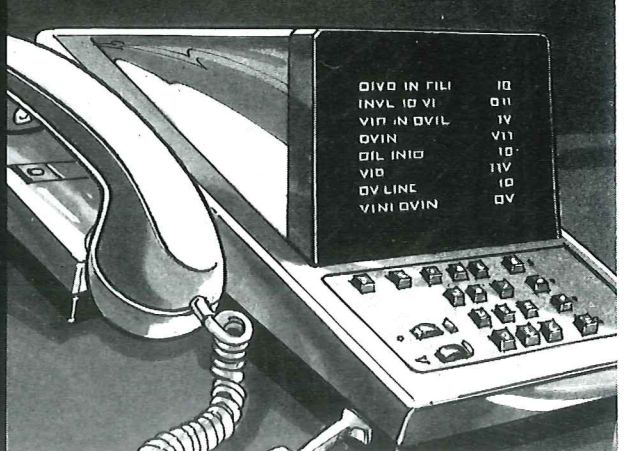

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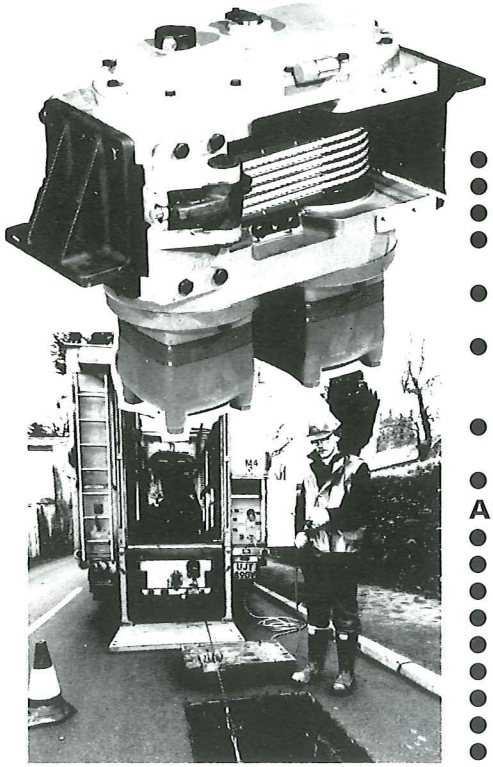

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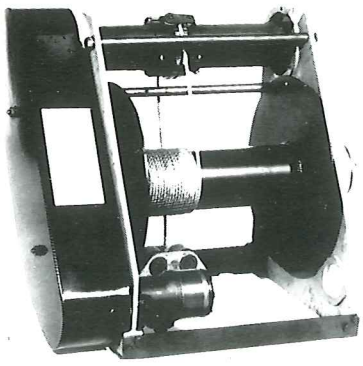

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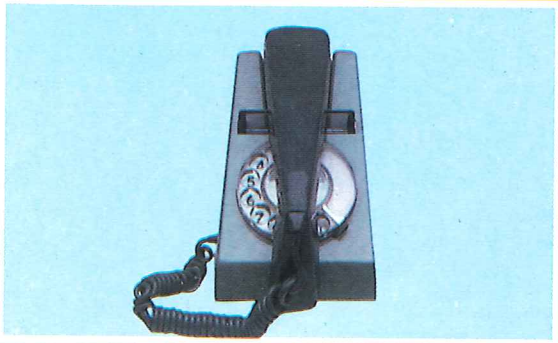

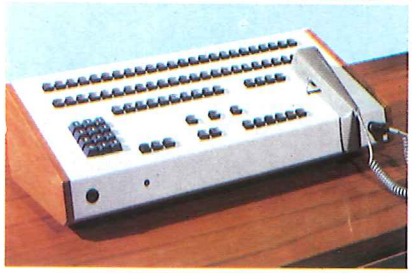
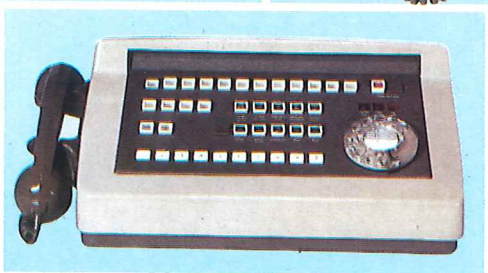

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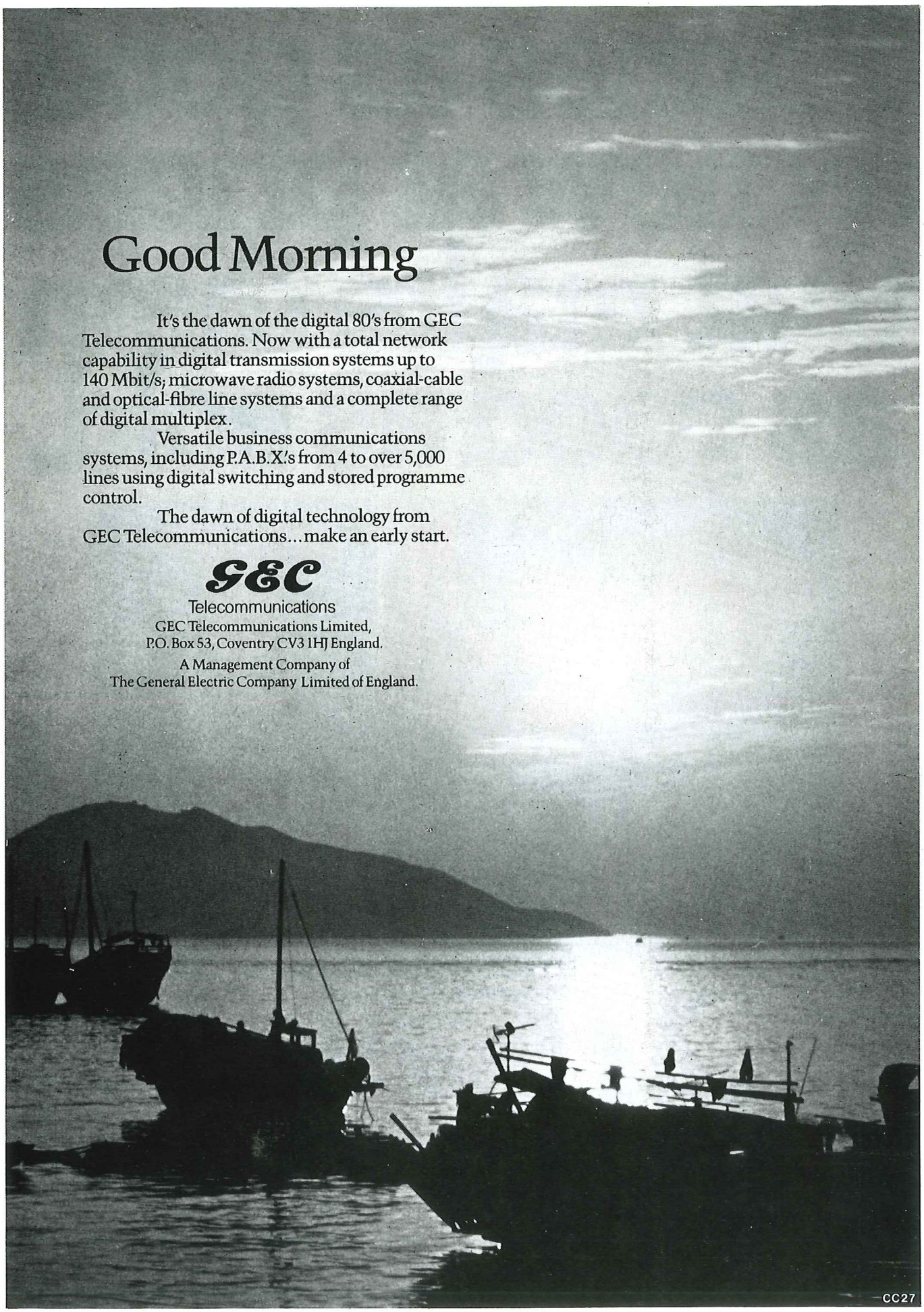
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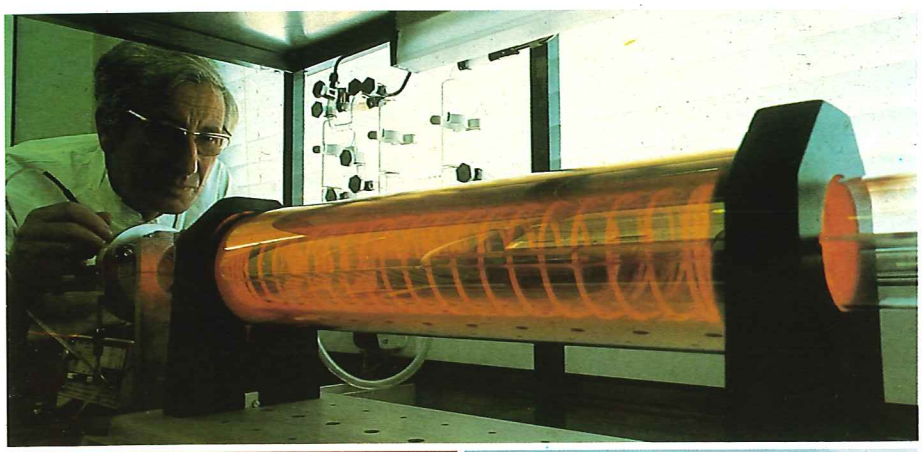

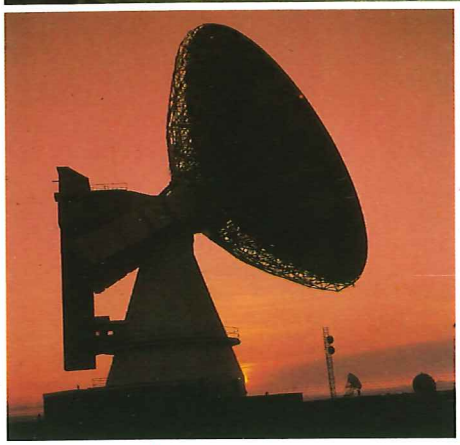

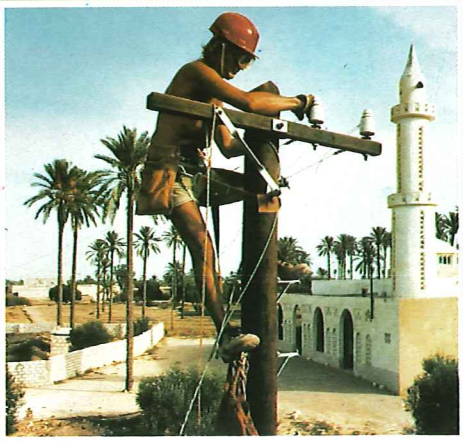

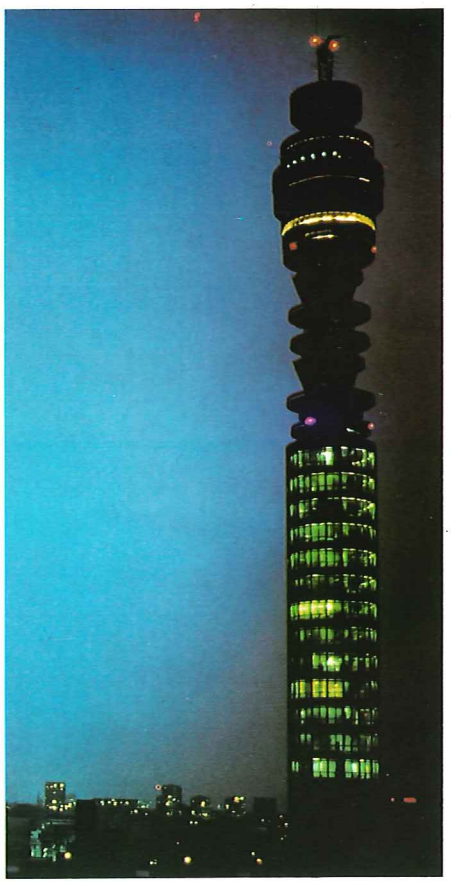

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